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Recent Developments in Highway Design

Progress in scientific planning the most important development. Aesthetic considerations receiving attention. Grade, alignment, vertical curves, compensation grades, superelevation, widening, grade crossings, detours, among the subjects considered

By A. G. Bruce*

Probably the most important development in the highway engineering field during the past year and the one having the most far-reaching influence on highway design has been the progress in scientific planning of city, county and state highway systems. The improvement of highways is now the greatest single industry in the country, and the yearly expenditure for these improvements has reached such vast proportions that sound engineering and business economics must supplant political considerations, or much of these expenditures will be wasted. The need for scientific planning is especially apparent in the territory surrounding large cities, and the major economic studies or regional studies undertaken during the past year have been in the congested areas around New York, Chicago, Detroit, Cleveland, Washington, Boston, Buffalo, Los Angeles and St. Louis.

The outstanding efforts in highway design during the past year have been directed toward safer and speedier transportation of motor vehicles. The newer designs in motor cars, buses, and trucks, together with the more liberal speed laws in the majority of states, have brought new problems which the engineer must solve. These problems involve better grade and

alignment, wider and smoother pavements, easier curves properly superelevated and widened, greater sight distance on both horizontal and vertical curves, more adequate guard rail and a greater degree of protection at railway crossings.

Within the past few years highway engineers have adopted a noticeable change in attitude toward the aesthetic side of highway improvement. The influence of the landscape engineer is responsible in

a measure for this change, but the dawning appreciation of natural beauty on the part of the general public is probably the chief reason. It is no longer sufficient that our highways be travelable; they must also be pleasing to the eye, and to this end the engineer is called upon to develop road locations so as to bring out the natural beauty of the locality, preserving what he finds and supplementing it by landscaping devices where it is naturally deficient.

This consideration of the aesthetic viewpoint is particularly noticeable in the new road locations developed by the engineers of the Bureau of Public Roads in the National Parks and National Forests, but the principle is rapidly being adopted in so far as is practicable in the improvement of county and state highways.



ROADSIDE BEAUTIFICATION RESULTING FROM INTELLIGENT SAVING OF SPECIMEN TREES

*Senior Highway Engineer, Bureau of Public Roads.

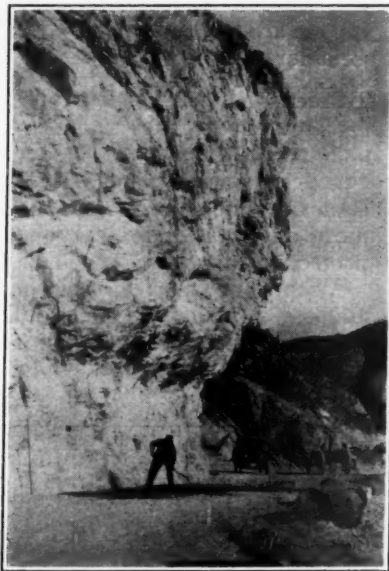


ROADSIDE PLANTING, CHEVY CHASE, MD.

This appreciation of natural beauty is responsible for the greatly increased use of short tunnel and half tunnel sections under picturesque overhanging cliffs and along precipitous canyon walls, where formerly it was the custom to blast away these irreplaceable landmarks, destroying the finest scenes and leaving ugly scars which took years to heal.

The public has come to realize the importance of preserving the natural beauty and saving it from disfiguration by unsightly shacks, signboards, lunch stands and refuse dumps. Some good work has been done by State and County legislation to curb this disfiguration, but legal obstacles instigated for selfish gain have prevented any real progress except in isolated cases. The most comprehensive legislation yet attempted is that of Massachusetts, where it is proposed to extend the city zoning idea to the land bordering the state highways.

In the construction stage of highway improvement much can be done to preserve and enhance the natural beauty by intelligent clearing of the right of way so as to save specimen trees, develop vistas of outstanding magnificence, and in building bridges and culverts which harmonize with the general character of the landscape. After the road has been built much can be done by intelligent planting but care must be exercised to avoid obstruction to the view at intersecting roads, unnecessary interference with the cultivation of adjacent farm land, and trying to obtain planting effects foreign to the natural character of the locality.



HALF-TUNNEL SECTION

GRADE AND ALIGNMENT

The plans for the past year's work clearly show a continued upward trend toward better standards of grade and alignment. The old Alpine standard for mountain road location involving low gradient but numerous "switch backs" or "hairpin" turns is giving way to standards more in keeping with modern transportation, which include wider curves properly banked and protected and somewhat steeper maximum grades. The European mountain standards we have followed so many years were designed for horse-drawn loads and are not satisfactory or safe for motor traffic.

In the details of laying the grade line there appear to be two schools of thought. One school contends that highway practice should follow railroad practice so far as practicable, with long grades of low per cent obtained by cutting down every hill and filling every valley. The other school contends that highway economics are not governed by the same considerations as railroad economics, and argue that highway grades in gently rolling country should fit the ground so far as practicable, thereby avoiding heavy excavation and unstable subgrade conditions. The followers of railroad practice justify large excavation quantities on the ground that lower unit costs result from large quantities, and that in any event the grading is but a relatively small part of the total cost of the complete highway improvement.

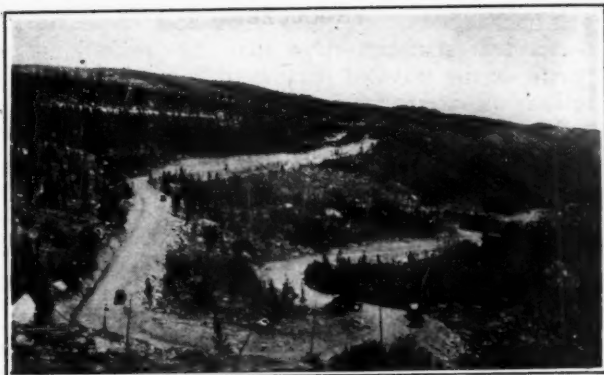
On superhighway development between large cities, the approach to railroad practice is undoubtedly justified, but on distinctly rural road development the majority of engineers are not in favor of indiscriminate cutting at every rise in ground simply to reduce the natural grade by a small percent. From the tourist's standpoint it is distinctly disappointing to surmount each rise with the anticipated pleasure of viewing the surrounding country, only to be walled in by a dirt bank which hides the best of the scenery.

VERTICAL CURVES AND SIGHT DISTANCE.

The length of vertical curves has steadily increased with the increase in volume and speed of traffic and



TUNNEL SECTIONS ON THE WIND RIVER CANYON HIGHWAY, WYOMING. F. A. P. NO. 118



DEVELOPMENT OF GRADES AND CURVES ON MODERN MOUNTAIN HIGHWAY

the necessity for greater sight distance. On heavily traveled roads the sight distance should not be less than 500 feet, and vertical curves of sufficient length to give this view should be selected.

COMPENSATION OF GRADES

Where it is necessary to use a curve of less than 500 feet radius on a grade of more than five per cent, it is common practice to compensate the grade in order that ascending vehicles may not lose momentum by slowing down. The amount of such compensation depends on the local conditions, but generally it should not be less than one-half per cent for each fifty-foot reduction in radius below 500 feet.

CROWN

Where proper care is exercised to develop surface trueness, a crown of one-tenth of an inch to the foot appears sufficient for hard pavements. All state specifications now require true surface finish and a $\frac{1}{4}$ -inch variation under a ten-foot straightedge is the usual tolerance permitted, but a motor trip through several states will show a considerable difference in the results obtained from similar specifications.

SUPERELEVATION AND WIDENING

On account of greater permissible speed of motor vehicles, the proper superelevation and widening of curves has become increasingly important. In eight states curves of one degree and over are superelevated, but in the majority of states the banking starts at three degree curves. The maximum superelevation used by most states is one inch per foot of width, but several states exceed this ratio and there is a demand on the part of many automobile users for superelevation based on the legal speed limit. On account of horse-drawn vehicles and slow-moving motor trucks and because of icy conditions in the winter, it will probably be advisable to compromise on superelevation until separate highways are provided for the different classes of traffic. The superelevation practice recommended by the American Association of State Highway Officials is based on the formula

$$E = \frac{V^2}{R} \text{ — where}$$

E = The maximum superelevation in feet per foot of width.

V = Velocity in miles per hour (35 recommended.)

R = Radius of the curve in feet.

Widening the curve usually starts on curves of eight degrees and the maximum extra width is about five feet. The widening practice recommended by American Association of State Highway Officials is based on the formula

$$W = 2(R - \sqrt{R^2 - L^2}) + \frac{35}{\sqrt{R}} \text{ in which}$$

W = Widening in feet.

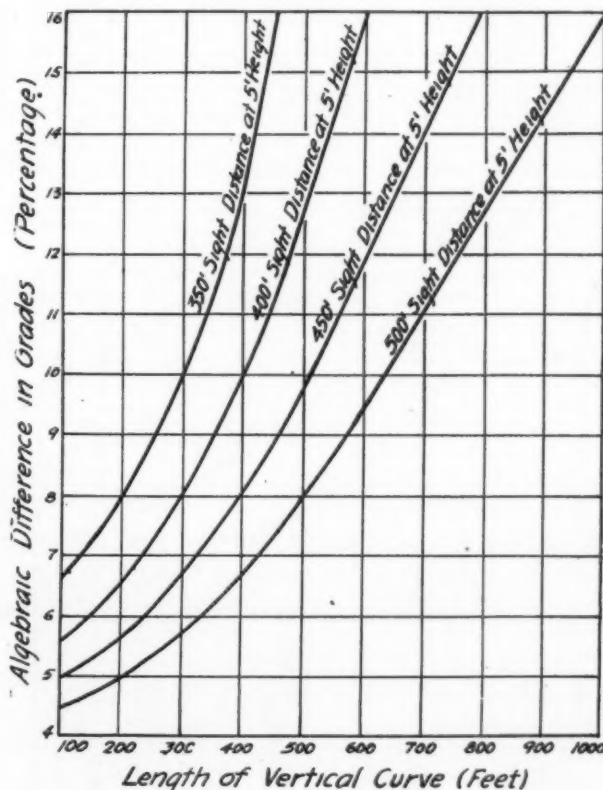
R = Radius of curve in feet.

L = Wheel base of vehicle in feet (20 feet recommended.)

This formula gives somewhat less maximum widening than the average practice of the state highway departments at the present time, but with the trend for flatter curves, widening becomes of less importance and already in one state widening on curves is no longer practiced.

WIDTH

Most highway engineers agree that 20 feet is the desirable width for a two-lane pavement, but, due principally to limited funds, the 18-foot width continues to predominate on State and Federal Aid construction. However, the mileage of 20-foot pavement is increasing each year and during the past year 20 per cent of the total hard-pavement mileage on Federal Aid projects was of this width and 70 per cent was 18 feet. Superhighways of four, six

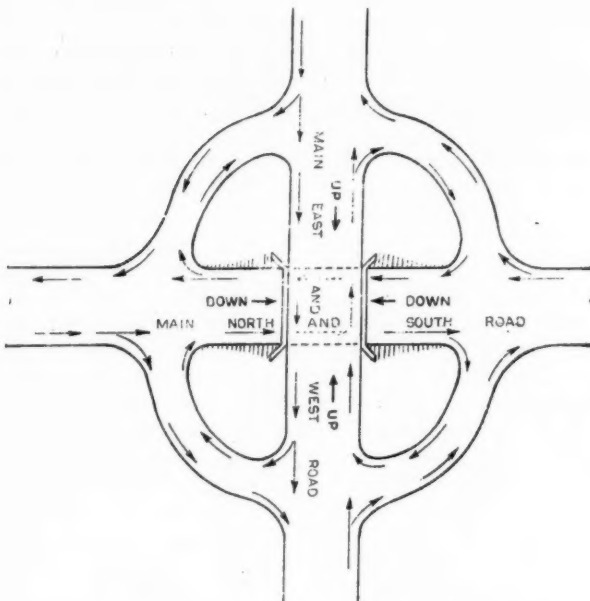


SIGHT DISTANCE CURVES

Showing relation of grades and vertical curvature to visibility. Example: Algebraic difference of grades = 8%. Sight distance desired = 500 feet. Vertical curve required = 506 feet

and eight lanes are being built in the outskirts of large cities and the next few years will see many miles of such developments.

Where the traffic flow is fairly constant, the divided roadway with parking and trees separating opposing traffic appears safer, more pleasing to the eye, and less fatiguing to the driver than the wide multiple-lane pavements. Where peak loads in one direction must be carried, as in morning and evening rush hours near industrial cities, better results may be expected if the lanes are placed contiguous so that a majority of lanes can be thrown open to predominating traffic.

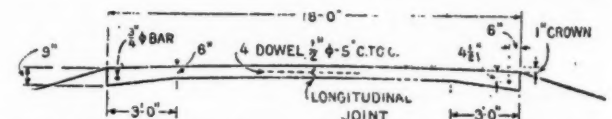


HIGHWAY GRADE-SEPARATION DESIGN
No left-hand turns or crossing of traffic

SHOULDER

Accident statistics show that cars parked on or partly on the traveled portion of the highway are a serious menace to traffic, and since emergency roadside repairs are unavoidable, it is obvious that shoulders six feet to eight feet wide should be provided. Many states are building shoulders eight feet to ten feet wide, and a few are building them three feet and four feet wide, but the prevailing practice is around six feet.

The full effect of shoulder width has been impaired in some states by the construction of culvert headwalls close to the edge of the pavement. In several

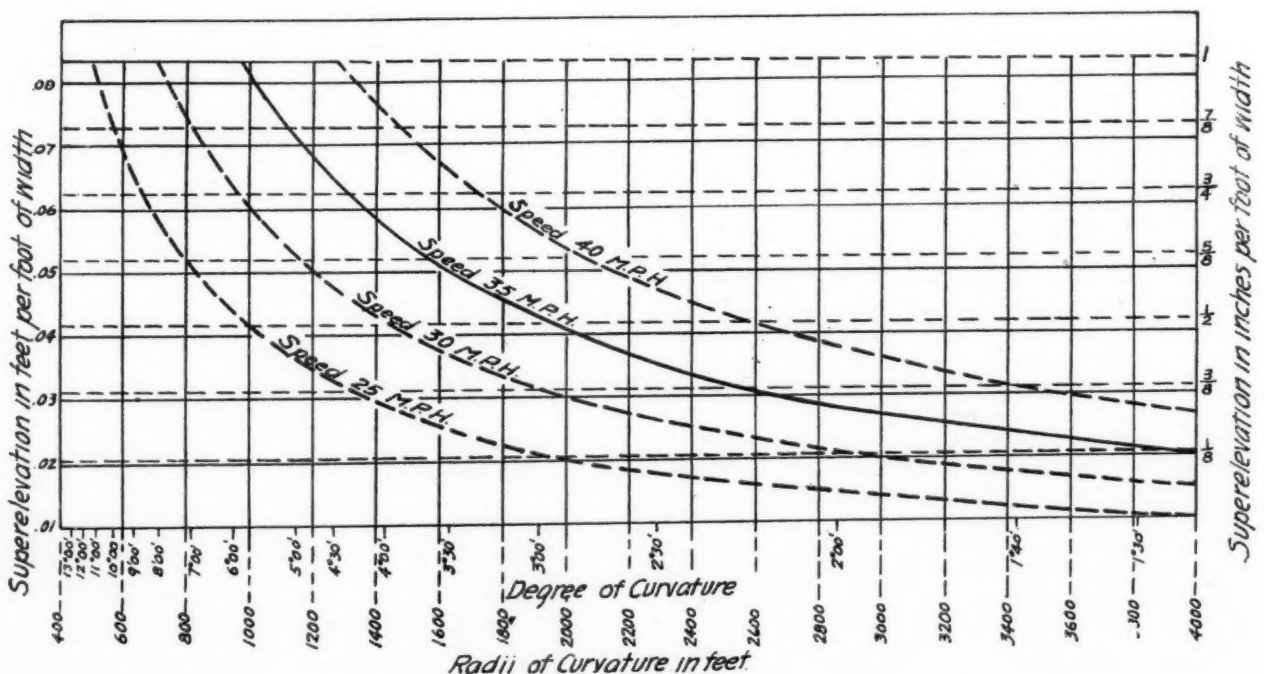


HALF-INCH TRANSVERSE EXPANSION JOINTS 60 FEET APART, WITH POURED OR PREMOULDED FILLER

states these headwalls are now being removed entirely or moved out to the ditch line so that the standard roadway width is maintained.

GRADE CROSSING ELIMINATIONS

Grade crossing accidents continue to take heavy toll of life each year in spite of the progress being made in grade crossing protection and elimination. There are about 250,000 grade crossings in the United States, the elimination of which is estimated to cost about twelve billion dollars or over fifty per cent of the total value of the railroads affected. It is obvious that only a small per cent of these crossings can be eliminated each year but many states are classifying their crossing and programming their elimination in approximately the order of relative danger and the terrible loss of life should soon begin to decrease.



SUPERELEVATION AT CURVES

Recommended by the American Association of State Highway Officials. Velocity recommended, 35 miles per hour



A BRIDGE DESIGN WHICH HARMONIZES WITH THE GENERAL CHARACTER OF THE LANDSCAPE

In proportion to the number of people using the highways, there has been a steady decrease in grade crossing deaths during the past ten years, the rate for 1927 being 8.5 per thousand automobiles registered against a rate of 21.7 in 1917.

CENTER PIER DANGEROUS

In underpass design, many railroads favor the use of a center bent or pier with a divided roadway. There is a slight saving in cost resulting from this design but the element of danger to highway traffic makes it decidedly objectionable and most highway engineers prefer under usual conditions one clear opening up to spans of 40 feet.

HIGHWAY GRADE SEPARATION

Some progress has been made in the separation of highway grades at important intersections, but such construction is expensive and more difficult to justify than railroad grade crossing elimination because the danger to human life is not so apparent. The output in cars per hour on a heavily traveled road, and especially on multiple-lane roads, depends in a large measure on the frequency of interruption due to cross traffic, especially left hand turns from one highway to another. Thus the elimination of the highway grades at important intersections has a direct bearing on the width and cost of the main highway, but it is not always easy to evaluate delays and inconvenience into dollars and cents.

DETOURS.

Some progress has been made during the past few years in the adequate posting of detours, but much remains to be done in many sections of the country where, through indifference or incompetence of those in charge, the road user is forced to find his way as best he can around the area under construction. Much of the engineer's work can not be understood or appreciated by the general public, but intelligent attention to detours is a simple duty which is understood and appreciated by everyone.

ROAD TYPES.

Oiling. During the past year considerable information has been gained in the bituminous treatment of gravel and sand-clay roads, especially in the oil processing method now so widely used in the Western states. There are in this country nearly 400,000 miles of gravel and sand-clay roads, constituting about 80 per cent of the total surfaced mileage, and

therefore the importance of protecting this tremendous investment is apparent.

Bituminous Concrete. In bituminous concrete construction there seems to be considerable activity in the promotion of the cold-laid types. In this respect we appear to be following the trend in England, where cold-laid types are popular.

On a few bituminous concrete jobs during the past year a machine finisher has been tried with apparent success. The procedure follows the usual practice for cement concrete pavement finishing and appears to produce greater density and greater trueness of surface than the hand raking methods.

Several recent experiments have been conducted in an attempt to utilize low-cost local materials in bituminous concrete construction. The most promising work was that done in Louisiana using crushed oyster shells for the mineral aggregate.

Cement Concrete. In the design of cement concrete pavements there is still a lack of uniformity which is somewhat difficult to understand. A study of the various designs used by the State Highway Departments during the past year indicates a wealth of individual ideas on the part of the designing engineer. Thirty states use expansion joints spaced all the way from 25 feet to 201 feet while 12 states use no expansion joints at all. Of the states using expansion joints, 15 use dowels across the joint and 15 use none. The longitudinal center joint has become almost universal practice but there are still four states that have not adopted it and seven states use no dowels across the joint. Fourteen states use no steel reinforcement, 7 states use edge bars only, 7 states construct only reinforced pavements and 16 states construct some of both types.

It is not surprising that the engineering profession is sometimes criticised for the lack of harmony in pavement design and to a certain extent the criticism is justified, but many of the variations in design are unimportant, and some of the important differences are justified by local soil, climatic and traffic conditions and by the difference in availability of materials. The individual ideas of the engineer are bound to find expression in pavement design as in other construction and there is no more reason to expect standardization of pavements than standardization of buildings, or bridges, or automobiles.

In finishing concrete pavements, machine methods have practically superseded hand methods, and on



IN THE CONSTRUCTION OF THE DONNER PASS ROAD IN CALIFORNIA, THE LOCATION WAS SPECIFICALLY CHOSEN TO DEVELOP THE VIEW EASTWARD TO DONNER LAKE

jobs of any size the specifications usually permit only machine finishing.

The volumetric proportioning of aggregate is no longer considered sufficiently accurate control, and proportioning by weight is becoming standard practice. Increase in yield with decreased unit costs are resulting from the scientific grading of aggregate by separating the sizes and recombining in proportions which will produce the maximum practicable density.

There has been considerable activity during the past year in the promotion of concrete curing by water substitutes. The materials tried out for this purpose have included sodium silicate, calcium chloride, asphalt emulsions, tar, both hot and cold, Hunt Process, wet burlap and sisalcraft. Complete reports on the results of these experiments are not yet available.

In order to minimize the inconvenience of detours, considerable thought has been given to the use of high early strength concrete in pavement construction and numerous experiments have been conducted with various kinds of cement and different conditions of mixing. The reports are encouraging as far as early opening of the pavement is involved, but sufficient time has not elapsed to determine the ultimate effect on the life of pavement.

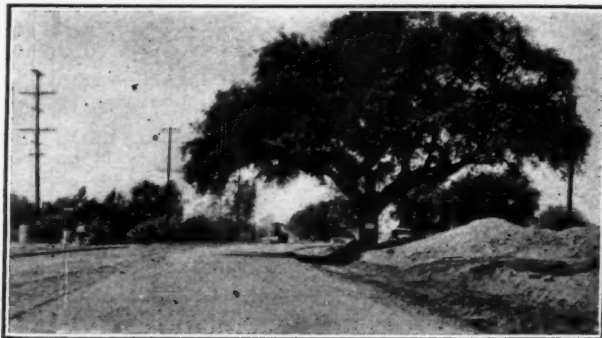
Preserving Roadside Trees*

To preserve beautiful shade trees along the state highway, by caring for those which now grace the road sides, is one of the duties impressed upon state highway employees.

*From "California Highways and Public Works."



THIS ROADSIDE TREE SAVED BY TREE SURGERY



LINE OF ROAD MOVED NINETEEN FEET TO
SAVE THIS TREE

A fine big sycamore tree, standing along the highway near Capistrano in Orange County, and much used by motorists who enjoyed its shade, was recently the subject of major tree surgery. The big tree had developed a large hole in its trunk which weakened it to such an extent that it was feared a strong wind would blow it down. Maintenance Foreman Hugh Henry removed the dead wood from the hollow trunk and constructed a filling of concrete, weighing about two tons, which has added greatly to its strength. The surface of concrete was roughened and marked to resemble the bark of the tree, and when a little stain is applied to the concrete, it will take a close inspection to detect the concrete substitute.

On the new Foothill boulevard in Los Angeles County, between Monrovia and Azusa, which is now under construction, an additional expense of \$450 was incurred in securing the right of way, in order to shift the highway and avoid the removal of a beautiful oak tree, which has stood for years a landmark of the community.

Accidents Decreased by Modern Road Construction

Chas. Upham, secretary-director of the American Road Builders' Association, recently has made some interesting statements on the subjects of the relation between highway design and safety on highways. In this he says that out of a total of 26,618 persons killed on state, county and city thoroughfares in 1927, 11 per cent of the fatalities occurred through accidents that were due to adverse physical conditions, such as narrow, defective or neglected roads and streets, improperly constructed curves, heavily crowned roads, dust, street and road barricades, and similar agencies. In 1926 the percentage of fatalities from such causes was 13 per cent, and the ratio of death has been reduced steadily each year since 1917.

This year curves are being banked and many of them are being abolished through relocation; crowns are being eliminated or greatly reduced; proper walls, rails and fencing are being provided at dangerous points; grades are being reduced or eliminated entirely; the dust nuisance is being eliminated; roads are being widened and in many instances entirely rerouted around or through congested centers; road and street openings and repairs are being held down to a minimum; grade crossings are being eliminated and underpasses or overhead structures built to accommodate intersecting traffic; blind intersec-

tions are being materially reduced; pedestrian tubes at many intersections in and outside of cities are being constructed; and altogether highway design, construction and maintenance are being made fully to conform to the demands of modern motor traffic in every particular. "At the present time," says Mr. Upham, "the necessity is not only for paved highways, but for wider and safer highways."

As a result of these improvements, intended to make roads safer for fast motor traffic, several states have raised their speed limits five to twenty miles per hour.

Effect of Impact on Pavements

The Bureau of Public Roads has been investigating the effect of pavement type upon impact reaction—whether or not certain types of pavement possess inherent cushioning or shock-absorbing properties, by virtue of which these types function to protect themselves or (when used as a surfacing) the bases on which they are laid.

The pavements on which the tests were made consisted of 2-inch Topeka on 6-inch concrete base; 2-inch bituminous concrete on 6-inch concrete base; 3-inch combined sheet asphalt and binder, one on 6-inch and one on 7-inch concrete base; 1-inch sheet asphalt on surface-treated water-bound macadam base; surface-treated water-bound macadam; nine stretches of 6-inch cement concrete, two of 7-inch, two of 8-inch and one of 10-inch; 2½-inch brick, one on sand and one on sand-cement cushion; and 4-inch brick, one on sand and one on sand-cement cushion.

The results so far obtained do not seem to be considered by the investigators as entirely satisfactory and conclusive, but they have made public the conclusions that:

"1. From the limited data in hand, it is indicated that bituminous pavements of the nonrigid type, such as surface-treated waterbound macadam, may substantially cushion the effect of impact forces.

"2. Bituminous-surfaced pavements, such as sheet asphalt, Topeka, etc., laid upon concrete bases show, in general, some indications of cushioning impact forces, but the magnitude of this cushioning effect appears to be relatively small, and in some cases there is considerable doubt as to its actual existence. It should also be pointed out that the differences observed between reactions for the bituminous-surfaced pavements and those for the unsurfaced ones are no greater than the differences found to exist between reactions for the various sections of unsurfaced concrete pavement.

"3. In general, the impact reactions of bituminous-surfaced pavements on rigid bases fail to show any marked or consistent change with changes in pavement temperatures up to 106° F. However, in the case of one nonrigid type of bituminous pavement (1-inch sheet asphalt on waterbound macadam base) a consistent substantial decrease in reaction with increased temperatures was noted.

"4. The data regarding the permanent deformation due to successive impact forces upon bituminous-surfaced pavements on rigid bases show only a small and not very consistent tendency to increase with increasing temperatures up to 106° F. The

limited tests of nonrigid types, however, show a marked tendency for these types to suffer greater permanent deformations as the pavement temperatures increase.

"5. The impact reactions of bituminous-surfaced pavements on rigid bases show no tendency to increase as the section becomes more compact, due to repeated impact blows.

"6. Within the range of thicknesses studied, impact reactions of uncovered concrete pavements do not appear to be affected materially or consistently by variations of slab thickness.

"7. Brick types in which the brick wearing surface was bituminous filled and rested upon a sand or sand-cement bedding course on a concrete base show no marked tendency to cushion impact forces.

"8. The reactions of brick types employing plain sand bedding courses are practically the same as those of types employing sand-cement bedding.

Effect of Road on Tractive Resistance

The Iowa Engineering Experiment Station in cooperation with the U. S. Bureau of Public Roads has carried on investigations on the "tractive resistance of automobiles and coefficients of friction of pneumatic tires," and the results of these experiments have been prepared by T. R. Agg, highway engineer of the experiment station, and published by the Iowa State College. The report gives, in 60 pages, a fairly complete description of the tests and the conclusions therefrom.

In summarizing the more significant results of the investigation, the report states that "there is no great difference in the tractive resistance of any particular vehicle on various road surfaces that are reasonably smooth and hard. In some instances the low or intermediate types give as low a tractive resistance as the high type paved surfaces. Paved surfaces in good repair do not give as wide a range of variation in tractive resistance as do the intermediate and low types, nor does the traffic resistance on pavements reach as high maximum values as those determined for some of the low and intermediate types."

The tractive resistance offered by mud is "due in part to the necessity of squeezing the mud away from the tire as it rolls through the soft surface layer, and in part to a certain springiness of the whole road crust."

In the case of a spongy subgrade under a thin road crust (a condition common on light gravel roads), "the yielding of the foundation under the load, although the road crust does not break up, adds approximately 50% to the tractive resistance at 20 miles per hour. This condition is perhaps of no great consequence so far as light vehicles are concerned, but is a very important one from the standpoint of the truck and bus operator. On a road in this condition, fuel consumption will be markedly greater than on the same road when the foundation is stable and unyielding, as it is when dry."

"Rough surfaces of a given type generally have a higher tractive resistance than smooth surfaces of the same type." In some cases, however, the trac-

tive resistance lessens as the speed increases. "With a certain type of recurring roughness, the wheel bounds in such a manner that the tire is partly off the road surface for appreciable time intervals and the distortion of the tire and the power loss therein reduced below that of a smooth surface. This apparent economy is doubtless more than offset by the impact effects on the vehicle and the discomfort to the occupants. Roughness of the erratic type due to neglected maintenance, which leaves pot-holes, fissures, and irregular bumps in the road surfaces, is an unmitigated nuisance."

"In building so-called 'traffic-bound' road surfaces, loose material is placed on the road to be packed by traffic." This investigation indicated that the tractive resistance on roads covered with loose material is approximately 50 per cent, or even more, greater than on the same road after compacting. "This cost is concealed in the every-day operating costs to the owners of vehicles, but it is none the less real. It is unlikely that the public realizes the situation, and perhaps it never will, but the practice is certainly open to serious question from the economic standpoint."

Progress in Road Construction Methods and Equipment During 1928

A wide use of adequate mechanical equipment has improved the quality of highway work at no increase in cost and frequently at a reduction

By C. N. Conner*

Road builders are making practical applications of the results of research, field experience, and studies of highway records. New ideas are not accepted because they are new nor are old ideas abandoned because they are old.

This policy is resulting in clearer specifications, a greater uniformity of standards, smoother and more durable riding surfaces, a better knowledge of costs and, in certain instances, lower costs for construction and maintenance.

A wide use of adequate mechanical equipment in both construction and maintenance has improved the quality of highway work at no increase in cost and frequently at a reduction.

A brief survey of the methods used in construct-

sand with the addition of suitable clay or loam, or other cheap natural binders.

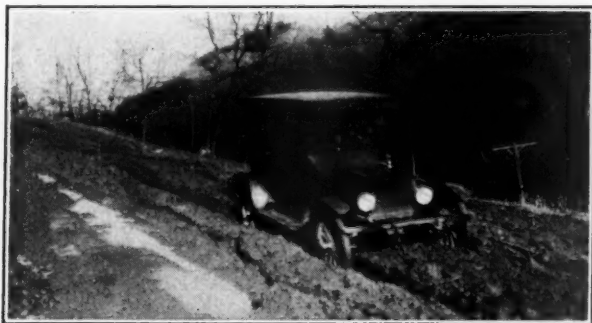
The operations include those commonly used in the construction of sand-clay and traffic-bound roads.

(2) Tile or stone drains are now more commonly used to prevent free water from entering a subgrade by laying them outside the pavement limits than by placing them beneath the pavement.

(33) Subgrade treatments with bituminous materials applied from a distributor have been reasonably successful in certain instances.

UNTREATED SURFACES OF SAND-CLAY, GRAVEL, CRUSHED STONE, SLAG AND LOCAL AGGREGATES

Roadway surfaces that are expected to carry light



SOME SOILS CONTAIN AS HIGH AS 90 PER CENT PURE MICA AND ARE DIFFICULT SUBGRADE TO HANDLE WITHOUT SPECIAL CONSIDERATIONS



THIN LAYER OF STONE AND SCREENINGS FOR SUBGRADE TREATMENT BEFORE LAYING MACADAM BASE, NORTH CAROLINA

ing the principal types of roadway surfacing will serve to illustrate this progress.

SUBGRADE TREATMENTS

There is a tendency toward practical applications of subgrade and drainage studies:

(1) By increasing the bearing power of clay soils by mixing with them sand, gravel, stone screenings, or other clean, granular material; and by stabilizing

traffic of automobiles and few heavy trucks are in such demand that improvements in their construction methods have been developed.

Good results and low cost are found where the materials used pass the 1-inch screen and are retained on the No. 10 screen. A binder, if added, should preferably be non-slaking in character; this however does not exclude clays, which may run as high as 20% of the surfacing in certain instances.

The construction methods are simple and consist of preparing the subgrade to a true and regular

*Engineer Executive, American Road Builders' Association.

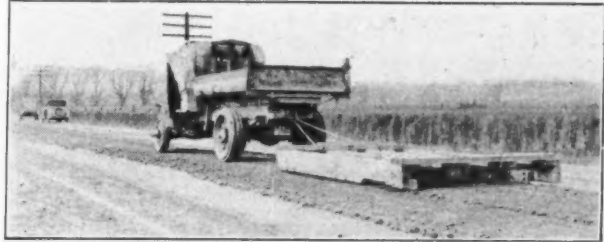


BUILDING A TRAFFIC-BOUND ROAD IN OHIO AT AN AVERAGE COST OF LESS THAN \$5,000 A MILE.

surface and then spreading the aggregates over the surface with road bladers and drags. The material is placed in just sufficient quantity to carry the traffic. New material is added from time to time as required. The most satisfactory surfaces of this type are seldom less than 20 feet in width.

NON-BITUMINOUS SURFACE TREATMENTS

To reduce dust and loss of surfacing aggregates on otherwise untreated granular surfaces, calcium chloride has been found effective in Michigan and elsewhere. The construction methods are to apply



THE DRAG AND ROAD BLADER ARE INDISPENSABLE FOR CONSTRUCTING AND MAINTAINING UNTREATED SURFACES.

BITUMINOUS SURFACE TREATMENTS

Because of the existence and continued construction of long mileages of gravel, stone, sand-clay and other untreated surfaces and because the maintenance costs of these surfaces commonly become excessive under comparatively light traffic, progress in bituminous surface treatments is worthy of special note.

There are two principal methods:

Method 1. In which the bitumen is applied in two or three applications to a well compacted surface; and each of the applications is covered with selected clean aggregate.

Method 2. In which the bitumen is applied and



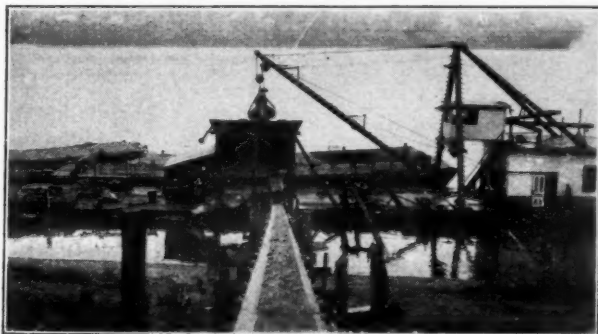
THIS TRUCK IS USED IN KENT COUNTY, MICHIGAN, TO HAUL THE CHLORIDE SPREADER, TO MACHINE GRAVEL SURFACES, TO HAUL NEW GRAVEL, AND TO REMOVE SNOW.

this material to the roadway surface from lime spreaders or similar devices. The surfaces are then maintained by blading and dragging. These applications have also been useful in laying dust and conserving loose surface aggregates during the period when traffic is using the road and before it is sufficiently compacted for a bituminous surface treatment.

mixed on the road with the aggregate already in the roadway surface or is mixed with newly placed aggregate.

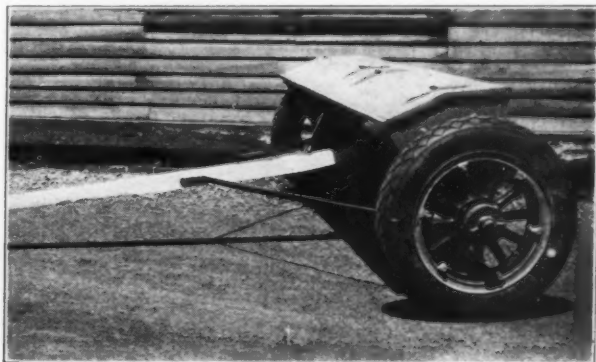
In certain instances both operations are done.

The equipment for Method 1, when best results are obtained, include power distributors, power and hand brooms, chip spreaders, light drags and light power rollers.



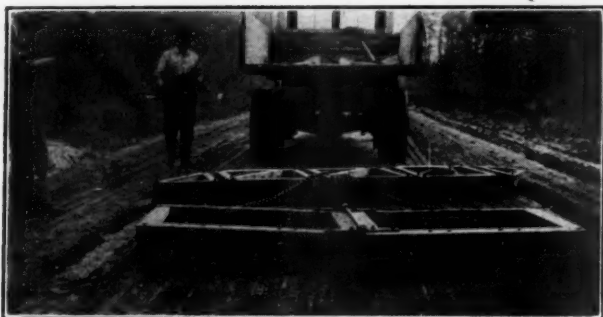
UNLOADING GRAVEL FROM BARGE TO STOCK PILE WITH 200-FT. BELT CONVEYOR.

Use of local material (Ohio river gravel) for stage construction.



SPREADER FOR CALCIUM CHLORIDE.

A lime drill on pneumatic tires gives a uniform distribution of chloride.



VARIOUS TYPES OF DRAGS ADD GREATLY TO THE RIDING QUALITIES OF BITUMINOUS SURFACE TREATMENTS

The equipment for Method 1, when best results are obtained, include power distributors, power and hand brooms, chip spreaders, light drags and light power rollers.

The equipment for Method 2, when best results are obtained, include power distributors, road bladers, drags, chip spreaders, and power rollers.

Smooth riding surfaces are usual when drags and road bladers are used to mix surfacing aggregates with the bitumen, and to shape the surface.

In spite of the fact that commendable progress has been made in the bituminous surface treatment field, much remains to be done in standardizing the methods of construction, clarifying specifications and taking some of the mystery out of this class of work.

The results of effective standardization and simplification will be far reaching in their benefits to road builder and material producer alike.

BITUMINOUS MACADAM, PENETRATION METHOD

Although one of the oldest types of roadway surfacing, bituminous macadam until recently has shown but few variations in construction methods over a period of fifteen years.

Those given below are not necessarily new but they are worthy of note.

The use of comparatively soft stone in sizes up to four or five inches for the coarse size.

A tendency toward the use of stiffer bitumens, that is, of lower penetration.

A limited use of cold application material, such



THE ROAD BLADER IS BECOMING MORE AND MORE POPULAR FOR SMOOTHING AND MIXING BITUMINOUS SURFACE TREATMENTS OF THE MIXED-IN-PLACE TYPES

as cut-back asphalts and emulsions for penetration macadam.

The use of chip and stone spreaders for uniform application of aggregates.

An increase in the construction of mechanical equipment, such as bladers and drags, to obtain smoother riding surfaces.

A tendency toward protracted rolling to obtain maximum density of surfacing.

A tendency toward using a minimum rather than a maximum amount of bitumen per unit surface area.

In general, the results of these and other improvements in the construction of bituminous macadam are smoother riding surfaces and less displacement or shoving under traffic.

BITUMINOUS CONCRETE

Bituminous concrete is here interpreted to mean any bituminous surface which is premixed in a mechanical mixer before placement on the roadway base course.

Several interesting developments have appeared, principally during the past year.

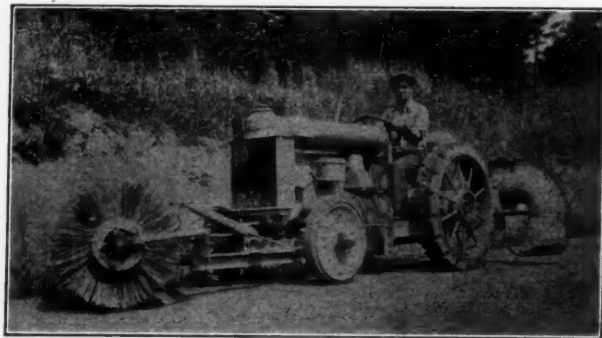
For the hot mixes such as sheet asphalt topping and asphaltic concrete, mechanical spreaders, rakers and finishing machines have demanded considerable attention. The results have in general been satisfactory and have resulted in smoother riding surfaces of uniform density. Where the projects have been of sufficient size to justify the use of mechanical equipment of these types, savings in operating costs have been effected.

Studies in plant design and operation, when completed, will doubtless show some valuable conclusions. These studies are being conducted by the Bureau of Public Roads in cooperation with the Asphalt Association. In the meantime, new devices for loading to plant driers have already reduced labor costs. Improved combustion chambers on driers have reduced fuel costs.

Proper spreading, raking, and particularly compaction, have much to do with the integrity and riding qualities of bituminous concrete, and by some are considered more vital than close limits for the grading of aggregate.

Asphalt technologists are now able to satisfactorily combine bitumen with local aggregates which do not compare favorably in gradation with the so-called ideal mixtures.

Bituminous surfacing mixtures which are premixed, shipped or hauled to the job and then laid



ROAD SWEEPER AND BLOWER USED FOR CLEANING SURFACE PRIOR TO BITUMINOUS SURFACE TREATMENT

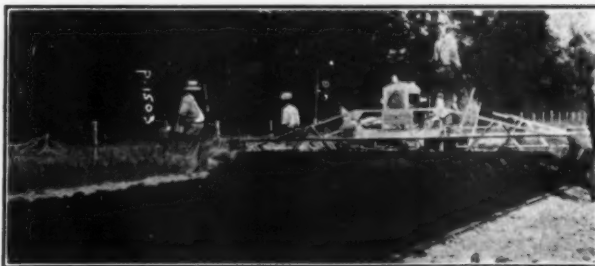
at atmospheric temperatures are growing in usage. The surfaces in this class, which might also include the natural rock asphalts, are used largely for widening and resurfacing existing pavements, macadam, bridge floors, and for new surfaces. Their principal advantage in construction, over mixtures which are laid hot, lies in the fact that no plant is required on the job, which is a distinct advantage for work in isolated sections or which may be so small that expensive plant set-ups would be prohibitive in cost. These surfaces can also be laid with a minimum of inconvenience to traffic. At present nearly all of these mixes are proprietary in character and are shipped from centrally located plants. After dumping, the cold mixtures are usually spread and raked by hand tools, followed by rolling with a power roller. In Indiana, the blade grader and heavy drag have been used effectively as construction equipment, their use having resulted in smooth riding surfaces.

CEMENT CONCRETE

Dummy Joint—The most outstanding recent development is the use of the weakened plane or "dummy" joint as a contraction joint between more widely spaced expansion joints. Several states and cities use dummy joints.

Dummy joints are made by pushing a bar into the concrete, usually to a depth of two inches, after the finishing machine has passed. This may be done either by a machine or by hand. Hand methods are most common. Usually a "T" bar is mounted on a plank provided with plow handles and the web of the bar is forced into the concrete in making both longitudinal and transverse joints. Sometimes a plane bar is forced into the concrete and left until after the final finishing operation, when it is pulled out and the slot is edged. Maryland and Delaware report a saving in the use of the dummy joint as compared with the deformed plate center joint. The dummy joint originated in Seattle.

Thick Edge Transverse—Another recent development is the use of thickened edges along longitudinal joints, in preference to the mortised joint or the dummy joint in either of which the edges are held together by tie bars. This is most common in the West, where steel is seldom used in concrete pavements for any purpose. This type of cross section



THE FINISHING MACHINE USED FOR TEN YEARS ON CEMENT CONCRETE IS NOW USED WITH GOOD RESULTS ON BITUMINOUS CONCRETE

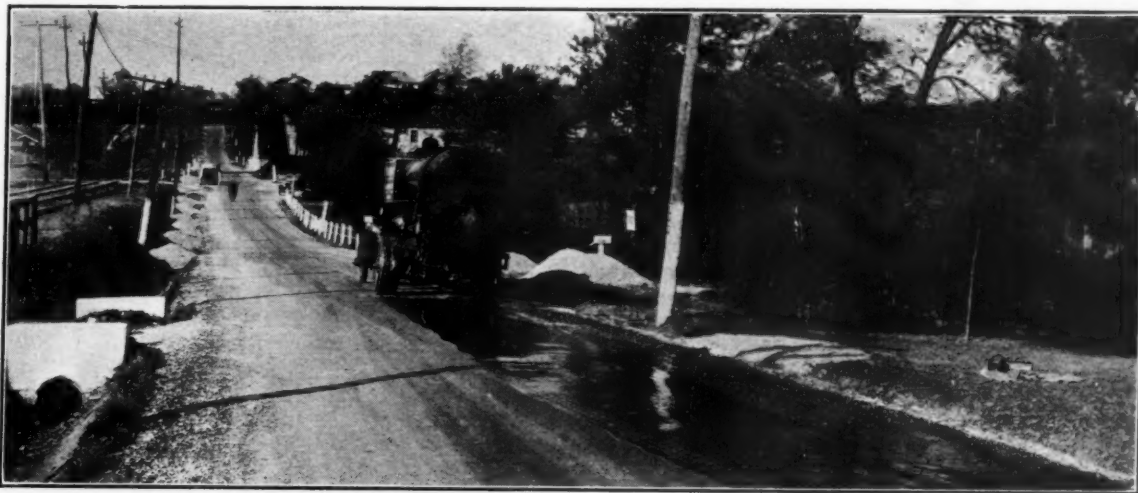
is popular also where pavements are built half-at-a-time, or where nine-foot slabs are constructed with the expectation that full-width highways will some day be built.

Spacing—It has also recently become common practice to divide pavements into comparatively narrow longitudinal strips. This is true of streets as well as of the wider highways. Usually longitudinal joints are spaced to bound traffic lanes, thus dividing the pavement into slabs nine or ten feet wide. That forms a definite traffic lane marker and eliminates longitudinal cracking.

Strength and Water-cement—In the Middle West, South, Southwest and West there have been many jobs during the past year on which the strength of the concrete or the ratio of water to cement were specified, but where the contractor or engineer proportioned the materials to suit local conditions. Without exception, these jobs resulted either in a lower cost or improved quality of concrete, and usually both these results were secured.

Weight Proportion—The past year saw an increase in the number of states in which batches were measured by weight, fifteen requiring or allowing this method of measurement in 1928 as compared with nine in 1927. The newer batching plants are admirably equipped to measure by weight, either using a dial scale or a combination of beam and dial which makes it possible for the scaleman to know when the material in the hopper is approaching the desired weight.

Water Measure—The development of more accurate water measuring devices has followed the general acceptance of the fact that quantity of water



THE DISTRIBUTOR IS A MOST IMPORTANT PIECE OF EQUIPMENT IN ALL BITUMINOUS SURFACE TREATMENT WORK



FIELD TESTING OF PRECAST BEAMS IS NEW AND SATISFACTORY

is as important as quantity of cement. At least three mixer manufacturers now claim to be able to measure water to within one quart of the desired amount. The new water tank is standard equipment on new mixers and can be installed on older mixers.

Riding Qualities—Each year sees an improvement in riding quality. In recent years this has been due partly to greater care on the part of workmen, partly to the new type of finishing machine, with its wider strike-off template, partly to the use of the dummy joint, and partly to the general adoption of the longitudinal float. This last instrument is an outgrowth of the longhandled float, doing the same work, but doing it better. It is a plank 8 or 10 inches wide and 12 to 20 feet long which is drawn across the pavement from edge to edge, with its long axis parallel to the center line. It acts as a straight edge which trims down any high spots and fills the hollows. Its chief recommendation is that it wipes out any ridges left by strike-off template, belt or tamp bar. These ridges are at right angles to the wheel path of vehicles, and thus produce maximum bump, while any ridges left by the longitudinal float are parallel to the wheel path, where they will not be felt. The longitudinal float also scrapes off excess mortar. On the Pacific coast, some pavements have been built with longitudinal floats as the only finishing tools.

Richer Mix—Instances in which richer mixes have been used to get high early strength concrete have been numerous during the construction season just ended. Frequently that has been done in the neighborhood of the larger cities, where traffic was so great that any delay in opening the pavement was expensive, but high early strength concrete has also been used when a long highway was nearing completion. There, by the addition of a small amount of cement in the work of the last few days, the whole highway is put into service several days sooner than would otherwise be possible.

Bituminous Curing—A new curing process has been put upon the market within the last few months. Curing is effected by spraying an exceedingly thin coating of asphalt over the finished concrete, the theory being that this waterproof coating will retain sufficient moisture to complete the hydration of the cement. While no exhaustive tests have yet been published, preliminary tests from several labora-

tories indicate that the process has considerable merit.

Beam Test in Flexure—The beam test is gaining in popularity. That is partly because of the cheapness and portability of the beam testing machine and partly because it is flexural, rather than compressive strength, in which the paving engineer is interested. No standard has yet been developed for the portable, cantilever testing machine, but a committee of the American Association of State Highway Officials is working on such a standard and it is hoped that it will be ready for the next construction season.

Thicker Sections—There is a tendency to build thicker concrete pavements and also thicker concrete bases. This is especially true in the vicinity of the larger cities where the extremely heavy traffic has broken up some of the thinner slabs. Around New York, Chicago, Cleveland, Los Angeles and other large cities, 10-inch and 12-inch concrete is common on the heavy-traffic, through arteries. Whether thicker bases or subgrade strengthening is the solution is a matter for research.

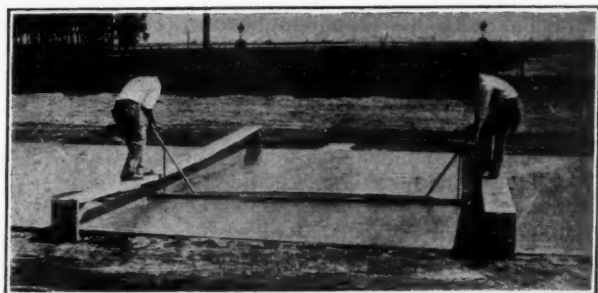
BRICK SURFACES

Filler—The filler now advocated is a bituminous or flexible material. Practically all of the filler now being used in modern brick pavements is asphalt. In a few instances, tar pitch mastic is used, and the tar interests are now working on the development of a tar filler containing fibrous matter that would make it suitable for use in block pavements. Some experimentation is being carried on with a view to determining the best consistency of asphalt to use as filler. The Ohio Highway Department is now conducting a test of this kind on a brick paving project in Ohio.

Portland cement grout, which was formerly used as filler on all high-grade brick construction, is still used to some extent for special work, such as street-car tracks, gutters and parking spaces. In such cases, however, provision should be made for expansion. Sand filler is used to a limited extent, especially in the south in cases where it is planned to strengthen the base course and relay the brick at



IMPROVED METHODS OF CRACK CONTROL BY EXPANSION AND CONTRACTION JOINTS ARE NEW. EXPANSION JOINT BUILT SUBMERGED AND THEN UNCOVERED



THE LONGITUDINAL FLOAT IN ACTION

some future time. In other words, this is a stage construction procedure.

The difficulties incident to temperature changes, such as occasional blow-ups, have been obviated by the use of a soft filler.

Thinner Brick—Experiments conducted by the U. S. Bureau of Public Roads on the circular track at Arlington showed that brick as thin as $2\frac{1}{2}$ inches was adequate for most heavy-traffic roads and streets. Use of $2\frac{1}{2}$ and 3 inch brick has been increased greatly since the results of these tests were made public in 1926. When the brick course is 3 inches or less in thickness, the brick are laid "flat," that is, with the 4 inch by $8\frac{1}{2}$ inch face exposed. Formerly, with the thicker courses, all brick were laid "on edge." When they are laid flat, less filler and brick are required per square yard of surface. The Arlington tests also seem to indicate that sand cushions are preferable to a cement-sand mixture. In sections of the country where granulated blast furnace slag is available, this material is greatly favored by the engineer for the cushion course.

Lugless Brick—The straight-sided wire-cut brick is now being used extensively instead of a brick with lugs for separating the courses. Such brick have been used for many years in the West, where they are known as "Vertical Fibre." They have only come into vogue in the East in the last few years. It takes good workmanship to fill such brick properly, although good jobs can be obtained, as is evidenced by the many completed pavements. The asphalt filler should be heated very hot and applied as directly as possible before it has time to cool and congeal. Many engineers favor the use of the so-called cart squeegee for this purpose. Because a lug brick is more fool-proof, so far as the filling is concerned, there are still many jobs where this type is specified, and the brick industry is ready to furnish a lug brick for the engineer in case he decides it is best for his purpose. The wire-cut lug, which is patented, is in about equal favor with the lug produced by repressing the brick.

Cushion and Base—The modern brick pavement is designed with a much thinner cushion course than obtained formerly. This is possible because modern specifications require the base course to be finished practically as smooth as the surface of a road. The

cushion should not be thicker than one inch and preferably three-quarters of an inch. In the southern section of the country, vitrified brick surface courses are laid on such foundations as natural sand, Florida lime-rock, crushed stone, chert, gravel, etc.; also in all parts of the country, brick surface courses have been laid on macadam and black base.

Simplifications—As a result of the work of the Permanent Committee on the Simplification of Variety and Standards for Vitrified Paving Brick, appointed by the U. S. Department of Commerce, the recognized varieties and sizes of paving brick are as follows:

Plain wire-cut brick (vertical fibre lugless)

$2\frac{1}{2} \times 4 \times 8\frac{1}{2}$ "

$3 \times 4 \times 8\frac{1}{2}$ "

$3\frac{1}{2} \times 4 \times 8\frac{1}{2}$ "

Repressed lug brick

$4 \times 3\frac{1}{2} \times 8\frac{1}{2}$ "

Wire-cut lug brick (Dunn)

$4 \times 3\frac{1}{2} \times 8\frac{1}{2}$ "

In 1927, eighty per cent of all shipments were of these five recognized varieties. Before this committee had begun its work, over sixty varieties and sizes were being manufactured generally.

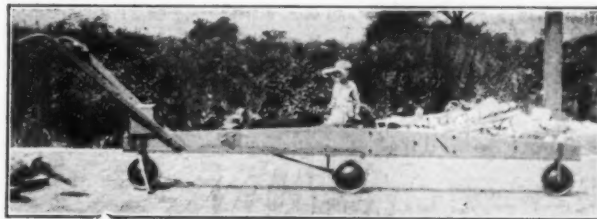
The use of a bituminous sand mixture for the



THE SQUEEGEE CART IS COMMONLY USED TO OBTAIN UNIFORM DISTRIBUTION OF BITUMINOUS FILLER FOR BRICK SURFACES

cushion course has been suggested, and at least one project in which such a cushion is being used is under construction in the city of Pittsburgh. In this case, tar was the bituminous material.

Another rather recent development (that is, in the last ten years) is the practice of using old brick pavements, thirty years or more old, in relaying projects. In the old pavements the brick were laid on edge, and by using them flat it frequently has been possible to avoid entirely the purchase of new brick. Many projects of this kind have been constructed and have the appearance of new pavements.



BUMPOMETER

When the center wheel moves up or down beyond allowable tolerance electric contact is made which rings a bell, indicating departure from required smoothness

Vitrified brick is found as a resurfacing course for old pavements that have begun to fail and break up under traffic. Many of these were built 14 and 16 feet wide, and by widening with a curb on each side and covering the existing pavement with an asphalt-filled brick surface course on sand cushion, the old pavement can be salvaged and the result is a fine appearing and substantial road or street. The cracks in the old pavements will not appear in the brick surface, because of its being composed of small units separated by bituminous joints each of which acts as an expansion joint, while at the same time the pavement has all the attributes of a rigid surface.

SUMMARY

To summarize briefly the progress in road construction during 1928 it appears that:

1. Subgrade and drainage problems are on the way to some practical solutions.
2. Stage construction is a sound economic policy.
3. The use of good local or shipped-in aggregates will make excellent secondary roads when constructed and maintained by suitable methods.
4. There are two outstanding methods for successful bituminous surface treatments on stone and

gravel roads: the dual application type and the mixed-in-place type.

5. Crack control in cement concrete pavements is being successfully accomplished by simple construction methods.

6. The use of mechanical equipment for finishing all types of bituminous roadways is resulting in smoother riding surfaces.

7. The practice of relaying old brick pavements, and the use of sand cushion under bricks with a bituminous filler between them, are recent practices developed during 1928.

8. Safety is receiving greater attention in the construction of highways. To take care of the higher legal speeds, curves are being flattened, sight distances increased, wider roadways of all types are being built and roadway crowns have much less rise than formerly. Super-elevation and widening is now the almost universal practice. Grade crossing elimination also is taking much of the engineer's time and of the state's money.

9. Improved construction methods and a wider use of adequate mechanical equipment are now the rule rather than the exception.

Recent Developments in Methods of and Equipment for Maintenance of Highways

Outstanding development has been tremendous increase in use of equipment. Purchase, operation and repair of equipment. Recent developments and general improvements in equipment. Developments in maintenance methods.

By Harry J. Kirk*

INTRODUCTION

In this article the author will consider as recent only those developments which have taken place within the last few years yet which have been in use for a sufficient length of time to prove their merit.

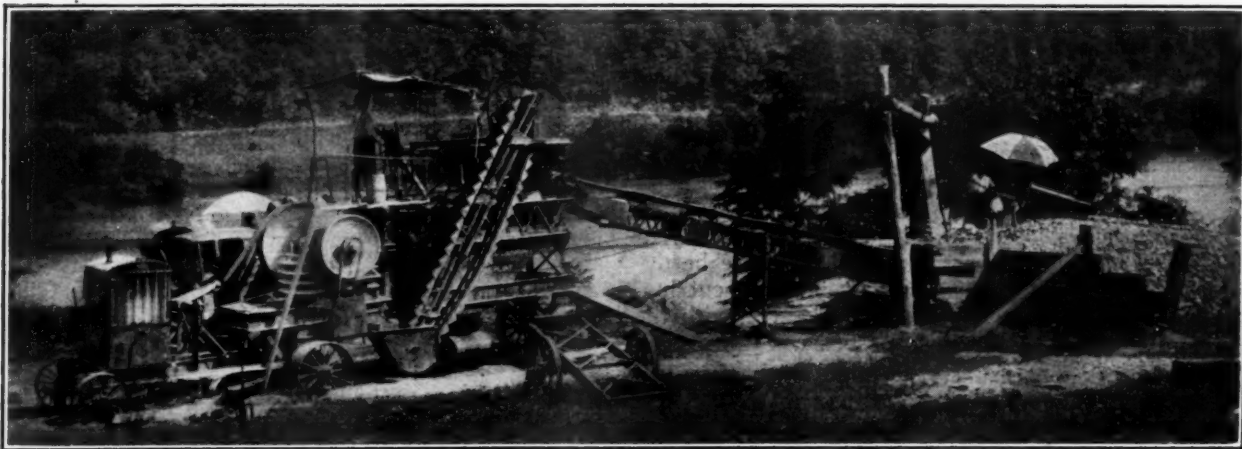
There are, strictly speaking, comparatively few original or absolutely new methods or machines produced for use in connection with highway maintenance work. Practically every innovation along this line is, in reality, a development, combination or refinement of ideas and methods already in use.

The most outstanding development of recent years has been the tremendous increase in the use of equipment for highway maintenance. Man-power and horse-power, which, a few years ago, were the backbone of any maintenance organization are fast giving way to the more economical and efficient machines available for this work. This increase in the amount of equipment operated by any present day maintenance organization presents problems of sufficient importance to be worthy of our intense consideration.

PURCHASE OF EQUIPMENT

Foremost among the factors fundamental to success in selecting equipment is accurate knowledge on

*Director, Ohio State Department of Highways.



CRUSHING OHIO RIVER GRAVEL FOR GRAVEL ROAD WITH A RUSSELL ONE-UNIT CRUSHING AND SCREENING PLANT.



DITCHING BY MEANS OF A RUSSELL ELEVATING GRADER

the part of the buyer of what equipment will best perform the work to be done. This is chiefly a problem of fact finding; facts about the job and facts about the equipment. Above all, the purchaser must have adequate knowledge and experience to enable him to make a wise decision, and must have the courage to stand behind his convictions in spite of the rosy claims made by an equipment salesman who may have had no practical experience with the equipment he is trying to sell.

OPERATION AND REPAIR OF EQUIPMENT

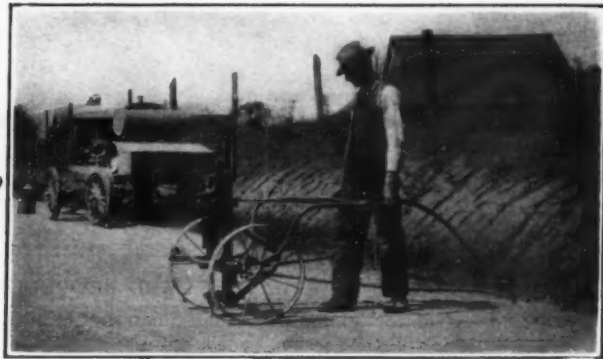
Intelligent purchase is by no means the most important problem connected with equipment. Operation and repair of equipment represents a considerably larger expenditure than does the original purchase price and an accurate but simple system should be established for keeping cost records, for only by a cost record can the actual cost of repairs or operation of equipment be determined.

Where the quantity of equipment justifies, a garage with trained mechanics and the necessary machinery should be established. A system of periodic inspection of all equipment during the working season should be arranged for and minor adjustments and repairs taken care of before more serious damage results. Constant vigilance must be exercised to see that equipment is not abused by speeding, lack of lubrication, exposure to the weather or over-loading.

But, regardless of the care given to any particular piece of equipment, it will eventually wear out or become obsolete, at which time it should be traded in on new equipment or salvaged for useful parts. In general, it will be found more economical to trade in an old piece of equipment on the purchase of new than to attempt to salvage useful parts unless these parts can be utilized for repairing obsolete equipment for which parts can be obtained in no other way.

RECENT EQUIPMENT DEVELOPMENTS.

Power Grader.—Among recent developments of equipment we find the power grader occupying the place of major importance. This machine is in reality a combination of a conventional blade grader and gasoline motive power which reduces by half the



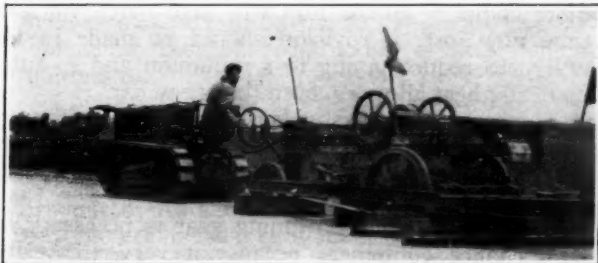
LEVELLING DOWN HIGH SPOT IN CONCRETE WITH INGERSOLL-RAND AIR COMPRESSOR AND BUSH-HAMMER

labor needed for operation. Although the power grader can be used to good advantage in the maintenance of earth or gravel surfaces, it has not as yet proven satisfactory for actual grading operations except in light work and under favorable conditions.

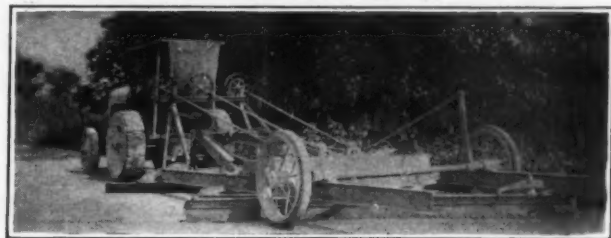
There are several types of the power grader in use today which differ principally in the type of traction provided, the location of the scarifier and the position of the operator's seat. The traction provided may be either wheel or caterpillar type. For ordinary maintenance work the wheel type is the more practical. The caterpillar track is recommended only on earth roads which become slippery after each rain, since this type of track involves additional expense both in the purchase price and in the cost of upkeep. The other items of difference in the various makes on the market consist principally of minor variations in design which are of comparatively small importance.

Elevating Grader.—Another useful piece of equipment (which, by the way, has been borrowed from the construction field) is the elevating grader. A light-weight elevating grader is particularly adapted for cleaning ditches in sections where the topography is not too rough. The material excavated is loaded directly into dump trucks and deposited on fills where needed at about one half the cost of any other method.

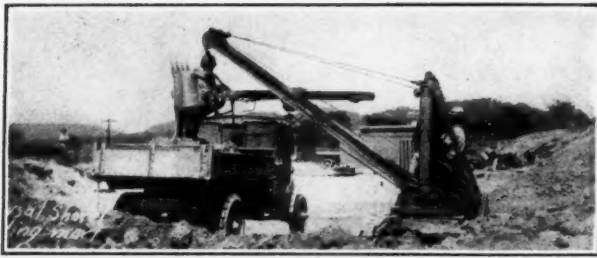
Air Compressor.—While the air compressor is not, in itself, new, many of its uses with special tools may be considered as of recent origin. The air compressor with its uses is of the greatest assistance to the modern road builder. In addition to the conventional jack-hammer, riveting hammer, drill and chisel, we have the more recently developed paint spray machine, the concrete pavement surfacer for cutting or grinding down high spots in concrete surfaces, the hand finisher for removing form marks from concrete structures, the light portable air hoist, and many other special applications of air power.



BAKER MAINTAINER IN PICKAWAY CO.



ADAMS NO. 6 MAINTAINER WITH INTERNATIONAL TRACTOR POWER



UNIVERSAL SHOVEL REPLACING HAND SHOVELERS
LOADING MARL
It is extremely difficult to load marl by hand

Crushing Unit.—Although crushing plants built up of several individual units have been in use for years in connection with the utilization of gravel or stone deposits, we have now a simplification and combination of these various units into what is in reality a complete plant mounted on wheels and in this way made readily portable without any dismantling being necessary. The elimination of expense in connection with the setting up of the plant, together with a more economical operating cost, makes the use of this unit advisable where a considerable amount of material must be produced from several different pit or quarry locations.

Trucks and Tractors.—While nothing revolutionary has appeared in the truck or tractor field within recent years, there have been several innovations introduced which are of interest. For use with the light-weight tractors we now have several attachments such as mowing machines, rotary broom sweepers, power scrapers, hoists, and a host of others. Of recent development in the motor truck we have the relay axle, three-way dump body, dual-drive rear wheels, and the general use of the electric starter, four-wheel brakes and other refinements which originally appeared only on passenger cars. Although the trend until recently has been towards heavier equipment for general hauling work, there has been a pronounced change of sentiment in favor of the light and faster truck within the last few years. The fact that license fees are now generally based on the weight of the vehicle has been partly responsible for this trend towards lighter equipment. The enactment of load limit legislation and the more strict enforcement of these laws also tends to discourage the use of trucks with more than two or three tons capacity.

Gasoline Shovel.—The use of gasoline power, which was practically limited to propelling vehicles



TRUCKCRANE SHOVELING OUT SLIDE

a few years ago, has now been adapted to practically every power need in the highway maintenance field. The one piece of steam equipment which stood the onslaught of gasoline until recently has been the power shovel. At the present time there are several makes of gasoline shovels on the market in a variety of sizes, most of which will perform very satisfactorily and much more economically than a steam shovel if the work is other than at a permanent location where coal and water are available at low cost. The small power shovel using a light tractor motor as a power unit and with a dipper capacity of about one-third yard is decidedly superior to any other piece of equipment for moving slips, cutting off points and for many other operations encountered in routine maintenance work.

Truck-Crane.—The light crane mounted on a truck chassis has become a familiar tool for unloading cars, for excavating, and for handling materials of various kinds. The truck-crane has the advantage of speedily moving under its own power and is a great boon to the maintenance organization which has enough work of this kind to justify the purchase of a portable crane.

GENERAL IMPROVEMENTS IN EQUIPMENT

Within the last few years there has been a marked improvement in all classes of equipment; partly in prolonging the life of the machine by using newer and better ideas of construction. Of interest along this line we find the adaptation of roller bearings to practically every bearing point where the use of them would be advantageous. We now have roller bearings carrying motor crank-shafts, and cam-shafts, grader wheels, and used in many other places where their use cuts down friction and eliminates trouble.

The adaptation of rubber tires to mowing machines, tar-kettles, graders, trailers, tractors and many other kinds of equipment is another recent development which has gone far towards lengthening the life of equipment as well as increasing its efficiency.

New Equipment Needed.—Road equipment is much better designed than it was a few years ago. Teams formerly were used much more extensively, but they have been largely displaced. Much trouble was experienced awhile back attempting to use tractors to pull machines designed for teams. And while we have little of this sort of trouble today, yet there is much room for improvement in other ways.

The chief source of trouble occurs where the manufacturer's engineers do not have the practical knowledge of the work the machine has to do.

Motor truck bituminous distributors need wider tires on penetration macadam work. Better heating facilities, in the way of a burner made of metal of higher heat-resisting quality and designed to secure more complete combustion will save much valuable time now lost. Provision should be made in the design to reduce piping to a minimum and to automatically heat all pipes, even the spray bar.

A street sweeper should be provided of more sturdy design than the ones still being manufactured and never intended to be pulled by tractors or moved at high speed from job to job.

In general, a better running gear is necessary on maintenance equipment because it very frequently

must be moved, and moved in a hurry. This applies to belt car unloaders, tar kettles, concrete mixers and other machines.

We are doing more and more maintenance work in the winter. This is because our roads are used more in the winter than formerly. Note the popularity of the closed car and the increased use of the motor truck in business. This means that we must provide greater protection against cold for the operators of trucks, graders, etc. For the same reason I favor closed cars for all engineers and superintendents who must drive long distances in all kinds of weather.

There is a big field for new equipment on maintenance operations on rural highways.

A central mixing plant lay-out for mixing cold patch bituminous materials would meet a popular demand.

A central mixing plant for concrete road repair would fill a need. It should be designed to set up at the railroad siding using say a 10-L size mixer on rubber-tired trailer, batch boxes and belt conveyor to charge the mixer.

Where the mixer must be placed on the road and half the road kept open to travel on concrete road repair, a mixer is needed that can be turned 90 degrees for loading the skip on the pavement.

Half the labor in erecting guard rail is in digging post holes. I would suggest that, in view of the many attachments made for use with various tractors, that a post hole digger using the tractor motor for power would fill a long-felt want. This problem might also be solved by designing a post hole digger to be run off an air compressor.

DEVELOPMENT IN METHODS.

Some of the developments which have taken place in methods involve recently introduced equipment and some do not.

Traffic-bound Road Surfaces—Foremost among recent developments is the progress made in stage-construction and maintenance methods in connection with the traffic-bound type of road surface. While this type is probably one of the oldest in existence, the improved technique of today has kept it from becoming obsolete and has given it a place of major importance among the various types of surfaces now in extensive use. The traffic-bound surface owes its popularity to its low cost of construction, which may be distributed over a period of years in the form of stage-construction, travel being permitted to use the road during construction periods in practically every case.

The development of a traffic-bound road consists of periodic widening of the road bed and the adding of thickness to the metal whenever traffic increases demand a wider and heavier road. In this way, the road need only be improved to a degree sufficient to take care of present-day traffic requirements, and the immediate cost of construction is thus kept at a minimum.

Compensating the low cost of construction is the relatively high cost of maintenance for this type of surface, which becomes prohibitive where traffic amounts to over 1,000 vehicles per day. Even this amount of traffic cannot be taken care of economically unless modern equipment and methods are employed in maintenance. The development of equip-



PAINT SPRAY MACHINE IN OPERATION

ment for use in connection with traffic-bound maintenance has made it possible to maintain splendid surfaces under traffic which would have been the despair of the maintenance engineer of a few years ago.

Among the greatest objections raised to the traffic-bound type of surface we find the danger of loose surface material and the dust nuisance. The two most widely used methods of overcoming these objections consist of treating the surface either with calcium chloride, or with tar or asphalt applied by either the "skin" or "mulch" method. Which of these methods should be employed depends primarily on the strength of the roadbed. In cases where a traffic-bound surface has been built up and compacted over a period of three or four years until no spongy spots develop in wet weather, the bituminous surface treatment is to be preferred. On sections where the metal is thin or where the traffic does not justify the expense of a bituminous treatment, the application of calcium chloride proves very beneficial. Care must be taken not to apply calcium chloride too liberally or too late in the season, since trouble will be experienced during the winter if there is excess of moisture in the roadbed. In general, a first application of $1\frac{1}{4}$ lbs. of calcium chloride per square yard followed at 60-day intervals with $\frac{3}{4}$ lb. applications will control the dust to a satisfactory degree and will not cause the surface to become excessively sloppy in wet weather.

Within recent months considerable "retread" surfacing has been applied successfully on traffic-bound surfaces. This was described in the September issue of PUBLIC WORKS, page 346.

In general, any of these types of surface treatments removes the dust menace, provides a smooth surface which reduces operating costs of the vehicles using the road, and conserves the material in the surface which would otherwise be worn out or dusted away.

The smooth riding surfaces obtained on bitumin-



TWO HUNDRED FEET OF 24-INCH BELT CONVEYOR CARRYING GRAVEL FROM BARGE TO UPPER RIVER BANK

nous surface traffic-bound roads have made our older pavements, particularly our old macadam pavements, look very bad in comparison. In order to overcome roughness of these old macadam pavements, made more apparent by the higher speeds of today, we have been applying some of the same methods so successful in producing the wonderfully smooth surfaces on traffic bound roads, chiefly the long sled drag. The large, heavy drags pulled by tractors are being used now quite extensively whenever an old macadam pavement is given a bituminous surface treatment. The results so far are very gratifying.

Salvage of Worn-out Pavements—Where construction funds are not available for the rebuilding of a worn out macadam pavement it is frequently possible to salvage the material left by placing a retread top directly over the pavement or by adding a top course of traffic-bound material which may be treated by any of the above methods when properly compacted. This procedure, of course, assumes that the pavement has failed through its own weakness and not from neglect. If a macadam pavement has sufficient strength and thickness to carry the loads imposed upon it, the surface should be patched and maintained as a macadam surface in preference to converting it to the traffic-bound type.

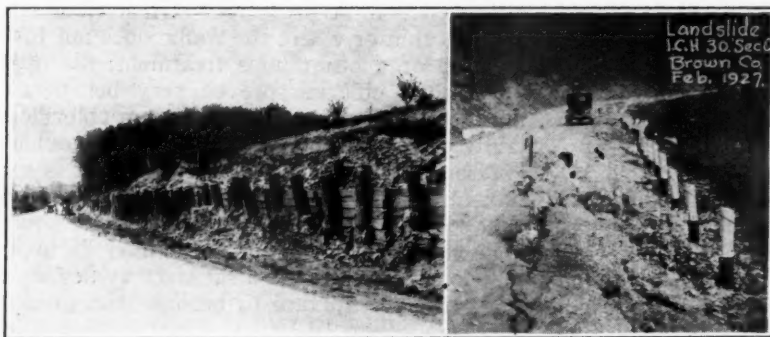
Stopping Landslides—One problem confronting the maintenance organizations in most hilly or moun-

enough explosive to thoroughly break up the surface of the strata without removing the overburden which carries the roadbed. It has been found that a heavy charge of explosive is essential in this operation and more failures occur from underloading than from overloading.

Of recent development in the control of slips we have perforated corrugated pipe, the use of which has proven beneficial in many slips where underground water may be tapped and led away. The control of surface water and the use of cinder fills to lighten the load on the slip wherever practical are also customary practices. It will sometimes be found more economical to bridge a narrow, deep, slip in preference to attempting a remedy for the slip itself.

The type of slip in which the movement is confined to the underground strata and which causes the surface to buckle and heave is the most difficult to conquer and in a case of this kind it will often be found advisable to relocate the road to a more stable foundation, if possible.

Explosives—In addi-



PILES DRIVEN TO PREVENT SLIDE

LANDSLIDE BELOW ROAD

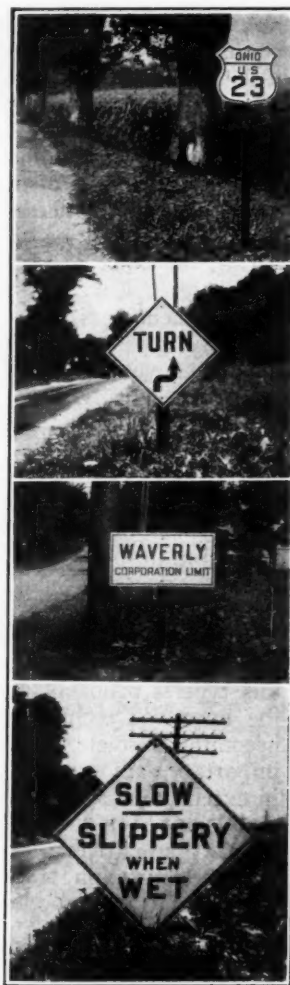
tainous sections is that of landslides. Landslides may be divided into three general classifications:

- (1) Slips moving away from the road which allow the roadbed to settle.
- (2) Slips moving towards the road which cover up the roadbed.
- (3) Slips in which semi-fluid material moves underground and causes the roadbed to heave and buckle.

Slips of the first two types are being successfully stopped by driving timber piling, where the slipping plane is not on rock. Where this latter condition exists, well casings may be driven into the rock strata. These casings should be reinforced with steel rails or bars and all voids filled with grout after placing. The penetration secured in the rock strata should be from one-third to one-half the length of the casing. If the rock stratum upon which a slip is moving is too deep to be reached by the well-casing method or if its angle from the horizontal is not too large, the use of dynamite is customary. Well-drill holes should be drilled to a depth of from ten to thirty feet into the rock strata and loaded with

tion to the use of explosives in the control of landslides, we find many other uses for explosives being developed. Dynamite, when handled by an engineer experienced in its use, has performed many tasks with more speed and economy than would have been possible by any other method. It is today being used extensively for removing old bridges and culverts, blasting out ditches, making post holes in stone ledges, and for many other special applications in addition to its customary uses.

Snow Removal—Realizing the need for year-round roads in regions affected by snowfall, there has been widespread activity in recent years in connection with the removal of snow. While nothing has been developed recently in equipment for this purpose which might be called radical in design,



HIGHWAY SIGNS

there has been a gradual development in design which has made for increased efficiency and service. The snow removal programs undertaken at the present time are of vastly greater magnitude than those of a few years back. Snow removal generally is accomplished with some form of plow; either straight or V-blades attached to trucks, or with heavy-duty rotary plows used with tractors for deep drifts.

Present day practice consists of starting the removal of snow before it has reached a depth of more than a few inches and the continuous operation of the plows until the storm has ceased. If more snow may be expected before thawing weather, the roadway through the snow is widened as much as possible in order to provide storage space for snow which may be removed at a later date. By handling the snow removal problem in this manner, the road is kept open to travel at all times and the formation of ice ruts is avoided to a large extent.

Considerable attention has lately been given to the control of drifts by removing obstacles causing them and by the use of snow fence to cause the drift to form before it reaches the road. While the use of snow fence in special cases is to be recommended, its general use cannot be justified since it is only partially effective in preventing snowfall on the road itself and may be practically useless if the wind is not blowing in its prevailing direction.

Traffic Surveys—As a step toward the more scientific planning of a highway system, several states, in conjunction with the U. S. Bureau of Public Roads, have made a systematic and thorough investigation into the facts concerning traffic volume and density by means of a traffic survey. As a result of a survey of this kind it is not only possible to accurately analyze the density, type and distribution of present-day traffic, but the need of future traffic may be scientifically forecasted and highway construction planned accordingly.

Route Marking—With the present-day increase in long-distance traveling by automobile, there arises the need of an intelligent and uniform system of marking highway routes. Under the leadership of the American Association of State Highway Officials, a uniform system of warning signs and route markers is being developed and considerable work has already been done by several states in this direction. This system of marking, as now developed, includes the marking of detour or temporary routes, warning signs which denote their significance by their shape as well as their wording, direction and distance signs at principal intersections which carry the names of principal towns enroute and their distance from the location of the sign, a standard "Road Closed" sign, and several other signs for use at described locations.

In connection with the establishment of detours, several states are now publishing detour maps at frequent intervals which give the traveling public full information concerning detour conditions throughout the state.

The taxpayers of Rockville Center, N. Y., voted on November 14 to issue \$1,800,000 in bonds for the construction of a sewer system and a sewage treatment plant for the village. The vote was 1,149 for and 961 against the proposition.

Pennsylvania Toll Roads Passing

The Pennsylvania Department of Highway has concluded negotiations for the purchase of the Lancaster and Fruitville Turnpike, in Lancaster County, for \$8,500, of which the state pays \$5,000. This leaves only one toll road in the state, the New Holland Turnpike, also in Lancaster County, and the engineers of the department have made a valuation survey of this pike with the thought of purchasing it if satisfactory negotiations can be completed with the owners.

F. A. Highway Work in 1928 and 1929

During the fiscal year 1928 there were completed 10,198 miles of Federal-aid roads at a total cost of \$205,043,784, of which the Federal government contributed \$88,056,984. At the end of the year there had been completed 71,074 miles of the designated Federal-aid highways, out of the total of 187,753 miles of such highway. There remains therefore more than 60% of the designated highway mileage still to be constructed.

By far the largest mileage both of completed and of designated Federal-aid highways is found in Texas, where 5,966 miles have been completed with Federal aid, while the total system is 11,691 miles.

The greatest amount spent on Federal-aid roads in any one state was \$19,211,852 by New York State, of which the Federal aid comprised only a little over \$6,000,000. Next in amount comes Texas with an expenditure of \$11,449,456, of which the Federal government contributed \$5,344,337. Next in order of expenditures on Federal-aid roads come Pennsylvania, Kansas, Iowa, Wisconsin, and Ohio, in the order given. From the expenditure of Ohio there is a considerable drop to the next state in the list. The smallest expenditure was by Arizona, \$655,350, of which \$467,215 was Federal aid.

Of the 71,074 miles of improved Federal-aid roads by the end of the fiscal year 1928, 10,611 had been only graded and drained, 34,169 miles was sand-clay and gravel, 1,427 miles was waterbound macadam, 222 miles consisted of bridges, and the balance was bituminous macadam, bituminous concrete, portland cement concrete and brick. Of these by far the largest part was portland cement concrete—17,516 miles.

Comparing the different kinds of improvements made during the fiscal year 1928, including both original construction and changes from a lower grade of road, portland cement concrete roads lead with 3,131 miles; gravel is next with 2,591 miles; then sand-clay 1,241 miles; bituminous macadam, 645 miles; bituminous concrete, 165 miles; waterbound macadam 126 miles; and brick 48 miles.

In addition to this, at the close of the year, initial improvements were in progress on 9,494 miles, and stage construction (improvement of previously improved roads) was under way on 1,285 miles.

With the beginning of the 1929 fiscal year we find approved for construction with Federal aid 3,118 miles; of which 1,022 miles is grading and

draining; 32 miles is sand-clay; gravel is 617 miles; waterbound macadam 108 miles; bituminous macadam 288 miles; bituminous concrete 39 miles, and portland cement concrete 998 miles.

The progress that is being made in stage construction, or in advancing to a higher type of surface roads originally improved with a lower type, is indicated by the fact that, of the total mileages given above, 598 miles of portland cement concrete pavements, 29 miles of bituminous concrete, 181 miles of bituminous macadam pavement, 34 miles of waterbound macadam, 755 miles of gravel and 397 miles of sand-clay were, in each instance, constructed on pavements formerly of a lower grade of surface; while more than 1,200 miles of roads was under stage construction at the end of the fiscal year, and 759 miles was approved for stage construction next year.

The above figures refer to Federal-aid work only and are from an official statement by the Bureau of Public Roads. Exact figures regarding the mileage of Federal-aid highway system improved by the states without Federal assistance are unavailable, but reliable estimates by state highway officials indicate that the total exceeds the mileage improved with Federal aid; and it is probable that the aggregate length of all sections initially improved to date is not far from 150,000 miles.

During the year 1928, 2,182 miles of roads were graded and drained but left with an earth surface,

while at the same time about 620 miles of dirt roads previously graded and drained were improved by some kind of surfacing. Moreover, the mileage of improvements made on roads previously improved by Federal aid was 25% of the year's work in initial improvement. In 1927 it was but 16% of the initial improvements completed. The 1928 stage construction exceeded by over 600 miles the completed mileage of similar construction in 1927, this in turn had far exceeded similar work done in previous years, and it is evident that improvement by stage construction is to become an increasingly prominent feature of future highway work. In some cases the improvement consists not only in improving the type of highway but also in relocating the road to improve alignment, eliminate grade crossings of railroads, or for other purposes.

Bureau of Public Roads Activities

Abstracts from the 1928 Annual Report of the Bureau

LOW-COST ROADS

During the last fiscal year the Bureau of Public Roads continued investigations with a view to developing types of road surface of low cost but capable of bearing light traffic the year round without being dusty in summer or muddy

Mileage of Federal Aid Roads Approved for Construction at the End of the 1928 Fiscal Year.

States	Grading and draining	Sand-clay	Gravel	Water-bound macadam	Bituminous macadam	Bituminous Concrete	Portland cement Concrete	Brick	Bridges	Total
Alabama	27.3	...	21.3	...	...	...	12.4	...	0.1	61.1
Arizona	...	...	...	...	...	4.2	...	...	...	4.2
Arkansas	9.9	...	...	...	...	...	6.2	...	...	16.1
California	...	...	20.0	20.2	...	1.7	1.5	...	0.3	43.7
Colorado	...	...	7.4	19.8	...	...	...	...	...	27.2
Connecticut	...	...	...	...	...	...	3.6	...	...	3.6
Delaware	...	...	...	8.0	...	...	4.9	...	...	12.9
Florida	12.6	...	...	...	18.0	...	...	...	0.1	30.7
Georgia	...	...	7.7	15.4	114.4	...	14.9	...	...	152.4
Idaho	22.0	...	72.7	...	1.8	...	6.9	...	...	103.4
Illinois	36.8	...	...	...	...	...	111.2	...	...	148.0
Indiana	8.4	...	...	...	...	...	52.9	...	...	61.3
Iowa	1.4	...	24.2	...	...	...	56.0	...	...	81.6
Kansas	80.1	...	...	...	...	...	25.9	...	0.3	106.3
Kentucky	62.3	...	...	...	...	...	0.4	...	...	62.7
Louisiana	5.3	...	...	...	1.0	...	...	...	3.5	8.8
Maine	...	...	6.6	...	1.0	...	6.4	...	0.2	14.2
Maryland	...	...	...	...	23.8	12.1	9.9	...	...	45.8
Massachusetts	...	...	...	...	5.6	...	...	...	...	5.6
Michigan	...	...	...	...	...	...	35.5	...	0.4	35.9
Minnesota	64.6	...	...	...	...	...	5.6	...	0.2	70.4
Mississippi	...	...	11.5	...	...	...	...	...	0.6	12.1
Missouri	20.6	...	5.5	...	...	...	33.6	...	0.3	60.0
Montana	32.1	...	189.8	20.3	...	2.9	...	...	0.7	245.8
Nebraska	...	23.2	...	...	...	...	...	...	...	23.2
Nevada	...	...	...	23.7	...	...	...	...	...	23.7
New Hampshire	...	...	...	...	...	...	9.1	...	0.1	9.2
New Jersey	...	...	...	...	...	...	...	...	...	...
New Mexico	15.3	...	40.5	...	...	...	0.3	...	0.5	56.6
New York	...	...	...	...	27.4	...	98.1	...	...	125.5
North Carolina	...	...	4.0	...	...	...	20.5	...	...	24.5
North Dakota	192.4	...	120.7	...	...	...	0.8	...	0.2	314.1
Ohio	14.1	...	...	...	...	...	77.7	3.4	0.1	95.3
Oklahoma	86.2	...	...	...	10.1	7.9	20.7	...	0.3	125.2
Oregon	6.6	...	...	...	...	...	79.7	...	0.1	86.7
Pennsylvania	2.6	...	...	...	...	2.5	1.5	...	...	82.4
Rhode Island	...	...	...	...	...	...	10.4	...	...	10.4
South Carolina	...	...	...	...	...	8.1	...	...	0.1	154.3
South Dakota	84.8	9.2	52.1	...	...	...	98.8	...	...	119.9
Tennessee	21.1	...	...	...	...	...	132.1	...	1.7	317.9
Texas	128.9	...	...	...	55.2	...	4.4	...	...	20.9
Utah	...	...	15.5	1.0	...	...	11.9	...	...	11.9
Vermont	...	...	...	...	...	...	...	...	...	...
Virginia	6.6	...	0.2	...	24.8	...	...	...	...	31.6
Washington	17.4	...	...	...	...	...	8.6	...	0.2	26.2
West Virginia	19.4	...	...	...	5.9	...	...	...	...	25.3
Wisconsin	...	...	16.9	...	...	...	35.3	...	...	52.2
Wyoming	41.8	...	...	...	...	...	...	...	...	41.8
Hawaii	1.7	...	...	...	...	...	...	...	0.1	1.8
Total	1,022.3	32.4	616.6	108.4	288.0	39.4	997.7	3.4	10.2	3,118.4
Under construction	3,471.5	847.5	2,160.9	217.8	441.4	168.4	3,365.2	47.7	58.7	10,779.1
Total F. A. work for 1929	4,493.8	879.9	2,777.5	326.2	729.4	207.8	4,362.9	51.1	68.9	13,897.5

in winter. In this it was assisted notably by the highway departments of California and South Carolina.

The treatment of fine crushed gravel and rock roads with asphaltic fuel oils, by methods modified and improved as a result of the co-operative investigation with California, has been especially effective in the arid and semi-arid western states where, on untreated stone roads, the dust nuisance had become intolerable. Already 2,500 miles of crushed stone roads have been treated by this method in nine western states, and when the season's current program has been completed there will be over 3,000 miles in eleven states. The treatment strikingly improves the riding qualities of the roads, completely eliminates dust, and reduces surface wear to a negligible quantity at a cost which, under efficient management, does not exceed \$1,700 a mile.

In the South Carolina investigation the aim has been to develop a similar treatment which will be applicable to various earths and stone surfaces and which will produce satisfactory results in the more humid sections of the country. The objectionable features of untreated sand-clay and top-soil roads in South Carolina are similar in some respects to those of the crushed rock and gravel roads of the west, in that they wear rapidly and are extremely dusty in dry weather. In addition to these defects, many of them become muddy during periods of wet weather. The experiments have been so successful in developing satisfactory low-cost surface treatment for roads of this type, resulting in greatly improved all-weather service, that considerable mileages of highways have already been improved by the new methods. Sand-clay and top-soil are used extensively in southern states for the construction of light-traffic roads, and the results of these investigations should prove of great value in that section of the country.

MECHANICAL FINISHING OF BITUMINOUS PAVEMENTS

The study being made by the bureau, as yet incomplete, of mechanical methods for spreading asphalt show that the ordinary mechanical finishing machine so generally used in concrete road construction work can readily be equally adapted to bituminous road construction. In a number of cases so far studied, not only has the use of the mechanical finisher produced a smoother riding surface, but it has also permitted the handling of more material at a lower labor cost. Thus, on a job in Hughes County, Okla., the spreading and raking when performed by hand methods placed a definite limit to the amount of rock asphalt surfacing which could be placed per hour. After the installation of a mechanical finishing machine the average rate of surfacing placed per hour of operation was increased from 218 square yards to 334, which was the limiting output of the heating plant. Other items of interest noted on this project were that with hand raking the labor cost of the entire road crew was \$12.50 per hour, but after the finisher was installed the labor cost was reduced to \$8.05 per hour, although more than 50% more

material was being placed, and that with the mechanical finisher the material was being spread as rapidly when it reached the road at a temperature of 300 degrees to 325 degrees fahrenheit, as was possible by hand methods when the temperature of the material was 375 degrees.

While the above job probably presented unusually favorable conditions for the use of the mechanical finisher, all the bureau's studies to date indicate that, even under the most unfavorable conditions, a proper use of the mechanical finisher will produce a smoother and more uniform riding surface and also handle a larger yardage of material than can ordinarily be done by present methods of hand raking.

SUBGRADE INVESTIGATIONS

Subgrade investigations now under way are considered among the most important of the bureau's physical researches—also the most difficult. They are being carried on in both the laboratory and the field. As a result of a survey of slide conditions in Ohio, West Virginia and Pennsylvania, it has reached the conclusion, among others, that "suitable drainage is indicated as the necessary corrective measure which will be effective in a large majority of cases."

FEDERAL AID FOR WAYSIDE PLANTING

Under the amendment of the Federal Highway Act, made last year, Federal aid may be given to assist in the planting of trees and shrubbery along the roadside. Already the states of California, Connecticut and Massachusetts have demonstrated how much can be done at a small cost to beautify the roadsides by judicious planting of trees, shrubs and perennial flowers. With the co-operation of forestry and horticultural authorities of the state and Federal government and the support of civic bodies and property owners, similarly attractive results can quickly and cheaply be obtained in other states as well.

CLEVELAND REGIONAL ROAD PLANNING

The most important economic research project of the last fiscal year made by the Bureau of Public Roads was that of planning a highway system to relieve traffic congestion in the metropolitan region about the city of Cleveland, Ohio. In the area affected by highway traffic originating in and destined to Cleveland there are parts of seven counties. In Cuyahoga county alone there are 4 cities, 49 incorporated villages, and 6 townships, a total of 59 more or less independent jurisdictions, each possessed of authority over the highways within its borders. Faced by a common problem—the provision of adequate arteries for the flow of the increasing traffic of a great metropolitan area—the authorities of the several jurisdictions had been unable to agree upon a concerted plan and their independent and frequently conflicting efforts had failed to produce a satisfactory solution.

At the request of the board of county commissioners of Cuyahoga county, the bureau agreed to undertake a survey of the highway traffic of the area and on the basis of facts thereby developed, to plan a consistent program of im-

provements designed to relieve the congestion that had arisen; on one condition, namely, that authorities of each of the jurisdictions involved would agree to carry out the plan presented and adopted. The condition was accepted, the survey has been made, and a plan of improvement has been drawn up which has met with the enthusiastic endorsement of all authorities.

As the fiscal year closes, work is already under way to put into effect some of the more important recommendations which, if carried out, will doubtless strike at the root of the traffic troubles of the area.

TOLL BRIDGES

The Bureau believes that the activity of promoters of private toll bridges on important state and interstate arteries is a serious menace to the free flow of highway traffic. These promoters "have been busy acquiring exclusive franchises to build bridges at commanding locations on the publicly built highways and, in contemplation therefore, to levy toll upon the annually increasing number of travellers. An investigation made by this bureau showed that on October 31, 1927, there were in operation, under construction, or proposed, in the United States 424 toll bridges, of which 217 were on Federal-aid highways. In the first session of the 70th Congress bills were introduced to authorize the construction of 122 new toll bridges and 67 were authorized by acts passed and signed by the President.

"Practically three quarters of all these bridges in operation or projected are or will be operated by private interests. The bureau has reliable information that such interests have sought by various means to obstruct the construction of free or publicly operated toll bridges at commanding locations. They have sought to enjoin the construction of public bridges in the courts; and they have attempted and in some cases succeeded in blocking legislation authorizing the construction of public bridges.

"With the purpose of discouraging such imposition of tolls upon users of the highways built in part with Federal aid, the Federal law at first prohibited the expenditure of any part of the appropriations made by Congress for the construction of roads which serve as the immediate approaches to toll bridges. Recognizing later the occasional desirability of resort to the toll method of financing in the cases of bridges built, owned and operated by the public itself, the Congress, by amendment of the law, specifically authorized the expenditure of Federal appropriations in payment of half the cost in public bridges, the state's portion of which is to be met by toll collections; and Federal funds may also be used in the construction of approaches to such public toll bridges."

"There is an active market for toll bridge bonds, and the public can sell on terms that are usually more favorable than those available to private builders.

"The existing public agencies can erect and operate the bridges as efficiently and economically as private builders. Under public auspices there is assurance of open competition by qualified contracting organizations for the construc-

tion of the bridge and the further assurance that the contract will be awarded to the lowest responsible bidder, conditions that have been noticeably lacking in much of the private construction upon which the public has been asked to pay dividends in the form of tolls.

"In consideration of these and other facts of similar purport, which it has established by study and investigation, the bureau generally opposes the construction of private toll bridges and favors construction under public auspices whether or not it be necessary to resort to tolls as a measure of finance. It has recommended against the granting of authority to private interests in numerous cases, when congressional bills have been submitted for consideration; but in many cases its recommendation has not been followed."

Biological Effects of Sewage Effluents in Streams

Brief description of effects on animal and plant life and on fish

R. W. Butcher, assistant naturalist with the Ministry of Agriculture and Fisheries, England, in November submitted a paper before the Association of Managers of Sewage Disposal Works with the title "Biological Changes Brought About by Sewage Effluents in Small Streams," of which the following abstract appeared in "The Surveyor and Municipal and County Engineer," of London:

The paper deals not with the easily seen gross and objectionable sewage pollution of a river, but with the effect of small and weak effluents that are almost unnoticed, but nevertheless do a certain amount of harm, and are often the beginnings of the extermination of life in a stream.

The main properties of a sewage effluent that react on the life in a stream are (1) its high oxygen-absorbing capacity, resulting in deoxygenation of the water. This considerably reduces the capacity of the river to support life, especially the animals that require free oxygen for respiration. (2) Its richness in organic matter and available food substances. On plants this will react as a "fertilizer," and the animals will have a great deal more to feed on, either detritus or plants. (3) Its high silt content which, though not always visible when the effluent leaves a sewage works, usually results in a precipitation of fine black mud on the bed of a stream. The silt will deposit in proportion to its size, and inversely as the speed of flow. Silt not consolidated by plants will frequently be washed away during floods and high water.

The changes will be illustrated chiefly from two localities: where a small effluent resulting from sedimentation and land filtration flows into the river Lark, near Bury St. Edmunds, and where a similar effluent flows into the river Chess, near Chesham. The former stream also receives during the winter months the effluent from a beet-sugar factory, and this effluent, like sewage, has a high organic content and oxygen-absorbing capacity, and results from this will also be referred to.

THE CHANGE IN PLANT LIFE

Because of the silting up of the bed of the stream, plants and animals found in stony stretches are replaced by those found in muddy and slow-flowing parts. Growth at first is greater because of the abundant food supply, but as an effluent has more and more suspended matter in it, so growth becomes less and unhealthy, as the small plants get smothered in a similar way to plants on shifting sand-hills.

Very weak sewage promotes the growth of diatoms at all seasons of the year, and that is all the change it will produce in a stream. A slightly richer effluent seems to favor the growth of small green unicellular algæ, the flagellates, such as *Euglena*, and those filamentous algæ (*Cladophora* and *Vaucheria*) known as "blanket-weed," which are a great hindrance to navigation and fishing. But all these plants are oxygen producers, and their growth, if not excessive, is all to the good. But with still stronger sewage there appear those fluffy, white growths known as sewage-fungus. There are several species involved in this term, the chief of which are (1) species of *Carchesium*—the bell animalcule; (2) *Leptomitris lacteus*, which feels velvety, not slimy; (3) *Sphaerotilus natans* and its closely related forms — *Cladotrix* and *Zoogloea*, which are very soft and slimy to touch. There are also other species met with occasionally, such as mould, *Fusarium aqueductum*, etc.

As the result of the study of the ecology of these forms the author has come to the conclusion that growth is promoted, not only by sewage, but by certain organic compounds present in artificial silk wastes, brewery waste, sugar-beet effluents, paper-works waste, etc. Growth is within rather narrow limits—the breaking down of the organic compounds must have proceeded far enough, but not too far. The particular species present is determined by locality, concentration and composition of the effluent.

THE CHANGE IN ANIMAL LIFE

Animals living in a river have roughly three places to choose from—(1) on the bottom; (2) among the weeds; (3) swimming about from place to place as fish do. In his work on the river Lark, F. T. K. Pentelow has divided the smaller animals into three societies. The Group A containing water-shrimp, may-fly and caddis larvæ, and many other animals, which live either among the stones in swift streams or in the weeds whether the stream is fast or not, but never in muddy places. The Group B containing alder-fly larvæ, certain molluscs and one or two other animals that live in the muddy places and rarely anywhere else. The Group C consisting of worms and gnat larvæ that live where the mud in the river is foul and therefore contains little oxygen.

Animals of the first group are driven away from their habitats by a sewage effluent that deposits organic mud on the bed of the river, but remain among the weeds if the oxygen content of the water is fairly high. But stronger effluents deoxygenate the water so that the animals are killed or driven away. First the Group A goes, then Group B gradually decreases, and only the gnat larvæ and worms of Group C remain. It is Group A that forms the usual and best food for the fish, and so

even the weakest effluent contributes in this respect to the reduction in value of the fisheries.

EFFECT ON FISH

It is very difficult indeed to ascertain what the effect of weak sewage effluents is on fish. Many statements are made, but they have no evidence to back them, and experiments with marked fish are badly needed. Fish can be seen waiting at the mouth of a sewer for food, but this can only be if the deoxygenating power of the effluent is low at that place.

It may be presumed that harm is done by the silting of the river-bed, driving away the fish-food, and inhibiting the breeding of such fish as the Salmonidæ that deposit their eggs on clean gravel; by interfering with the balance between fish, fish-food and plant-life; by lowering the vitality of all life when deoxygenation occurs even to a small extent; by rendering the fish more susceptible to disease, and enabling the diseases to flourish, especially when these are pathological, and by introducing into the river toxic products or by-products in distinction from deoxygenating effects.

Maintenance of Worcester's Sewerage System

In his annual report for the year 1927, Andrew B. Holmstrom, superintendent of the Sewer Department of Worcester, Mass., reported that the 4,510 catch-basins in the city were cleaned an average of approximately four times each. The catch-basin cleaning machine handled 18,575 cubic yards of material at a cost of \$1.20 per cubic yard, including the cost of hauling to the dump.

He stated that the cleaning of catch-basins was very difficult in 1927 on account of the great number of heavy showers during the summer months, catch basins filling up immediately after being cleaned. During the fall months, however, weather conditions favored the department so that all the basins were cleaned and left in a very satisfactory condition to receive the flow from thaws and spring rains. Ordinarily two catch-basin cleaning machines had been able to keep ahead of the work, but during the summer it was necessary to use three machines.

The Worcester sewerage system at the end of the year contained 138½ miles of sanitary sewers, 70 miles of combined sewers, and 86½ miles of storm sewers. The cost of maintaining this 294½ miles of sewers was \$73,390, or \$249 per mile. This is the highest cost of any year per mile as well as total; although in 1920 the cost was within \$1.50 of this. Since 1918 the cost has run over \$200 per mile each year, but prior to that it was always, since 1887, below that, and in 1898 it was down to \$110.47.

Cleaning catch basins by machine cost \$22,365 and other cleaning, \$6,756, in addition to thawing and freeing traps at a cost of \$3,751. Cleaning sewers during the year cost \$5,849. Maintenance of the two pumping stations cost \$8,195, and repairs to sewers, catch basins and manholes, cost \$3,769, and other repairs chargeable to other parties or on account of work done by the street department cost \$9,352. Other items brought the entire cost of maintenance of the sewerage system to \$73,390.

The inventory of property gives the construction

cost of sewers, catch basins, etc., as \$8,315,877, pumping stations \$18,998, sewage treatment plants \$4,103,648. Buildings, land, stores and supplies and other items bring the total inventory to \$12,669,657.

It is estimated that the population using the sewer system is about 185,000.

Tight Joint for Slip-Joint Sewer Pipe

By Emerson C. Hallock*

The specifications for the construction of trunk sewers for the Westchester County Sanitary Commission of White Plains, N. Y., called for a test under a four-foot head of water. This is very necessary as the pipes are under heavy ground water head and cross streams with inverts often 5 or 10 feet below water level. In constructing a section of this sewer one contractor, A. Gregorio & Company of New York City, used a pre-cast pipe manufactured by the Newark Concrete Pipe Company and, upon the suggestion of the writer, the contractor went into very careful details in making up the joints.

First, an extra heavy bituminous sewer compound, as manufactured by Hetzel & Company, was placed around in the sleeve end of the pipe which was in the trench; second, a thick continuous strand of jute was then packed into the compound; third, the next pipe was placed in position and jacked home by screw jacks, the spigot end forcing the jute and sewer compound into grooves in the sleeve end; fourth, the jute was calked inside and outside the joints, more being inserted if required; fifth, a 1:2 mortar was placed around the joint inside; sixth, a thin grout was poured around the outside, using a light packing of jute or burlap to hold the grout in the joint. The outside jute or burlap was removed after the grout had set and the balance of the joint, seldom more than $\frac{1}{2}$ inch, was filled with 1:2 mortar.

The mortar joints were not made up for a few days after the pipe had been laid, this giving the pipe a chance to settle without cracking the mortar joints.

Typical tests on two lines, one of 36 inches diameter and the other of 24 inches diameter, each 400 feet long, with combinations of 4-foot, 8-foot and 12-foot lengths, showed only about half of the amount of leakage allowed by the specifications, which was considerably less than a gallon per day per square foot of inside area for any 100-foot length. This method has been found to be very satisfactory and to be economical.

Refuse Incinerators in New York

New refuse incinerators are under construction at Hamilton Avenue near Gowanus canal, and at Apollo Street near Newtown creek, Brooklyn, New York, and contract will soon be let for a third at Flatlands Avenue and 57th Street. The completion of these, each of 500 tons capacity, will remove all necessity for carrying Brooklyn's garbage to sea.

*Chief Inspector, Westchester County Sanitary Commission, White Plains, N. Y.

In Manhattan an incinerator at Exterior Street and East 73rd Street is completed, and that to be built at 16th Street near the Harlem river will be placed under contract in the near future.

In the Borough of Queens a 270-ton incinerator is planned for Douglaston and another to cost \$445,500 at Juniper Swamp; also a 90-ton addition is to be made to the Arverne incinerator at a cost of \$152,380.

Digesting Sewage Screenings at Milwaukee

Experiments made in a large-scale plant which served as a basis for designing the plant described last month under the above title.

EXPERIMENTAL BASIS OF PLANT

As already stated, the design of this plant was based largely upon experiments conducted under the supervision of Dr. Willem Rudolfs as consulting chemist, the actual work of the test having been conducted by H. M. Heisig, research chemist of the Milwaukee Commission, the numerous analyses having been made by D. E. Bloodgood, chemist. Dr. Rudolfs had for several years been studying the mechanics of sludge digestion, with some attention to digestion of fine screenings, but the series of tests conducted by him in connection with the Milwaukee plant was believed to be the first test investigation carried out on a semi-plant scale.

Summarizing the results obtained, the experiments were conducted for a period of 290 days, during the last 188 of which fine screenings were added daily and a digestion schedule of 40 days was maintained. The experiments were made at an average of 81 degrees fahrenheit.

"The results show that the solids were reduced by 61% and the volatile matter reduction amounted to 66.8%. Decomposition of nitrogenous substances amounted to 59.5% and of fatty substances to 56%. The digested material dried readily and was spadeable in from 3 to 4 days. Pressing of the material for from 2 to 5 hours resulted in a cake with from 66 to 69% moisture. No accurate determinations could be made of the volume of gas produced (on account of the deficiencies of the experimental plant), but observations during a number of days showed a production of 5.3 cubic feet per pound of dry solids." The effective digestion capacity required to produce these results at this temperature was 0.115 cu. ft. per capita; but good sludge can be produced with the capacity reduced to 0.085 cubic foot (0.62 gallon) per capita. The digested sludge was intensely black and had no odor except the methane gas odor.

APPARATUS AND METHODS

The experiment was conducted in a tank with a gross capacity of 260 gallons, covered tightly, with three outlets on the side of the tank so that material for the analyses could be taken from the bottom, middle, and near the top, and solids or liquid withdrawn at will. The tank was placed in a water bath to maintain a temperature of the tank contents at 80 degrees.

Experiments were started on June 24, 1827, by filling the tank with 200 gallons of fine screenings, about 60 gallons of ripe sludge being obtained from the disposal plant at Mukwonago, Wisconsin, for seeding. The composition of the materials in the tank is given by table 1.

Table 1—Composition of Materials

Material	Total solids %	Ash %	N as NH ₃ %	pH
Ripe sludge	3.54	41.4	3.28	8.6
Screenings	8.40	8.9	4.66	6.2
Mixture	3.45	18.1	3.23	7.4

Total solids, ash and 24-hour bio-chemical oxygen demand determinations were made daily except Sundays throughout the 290 days of the experiment. The pH values were determined daily at the top, center, and bottom of the tank, and temperature records kept. Nitrogen determinations were made daily for the first six months and 3-day to 4-day composites made thereafter. The screenings added to the tank were analyzed for solids, ash and nitrogen. The completeness of the records permitted following the progress from day to day and making any desired calculations. In addition to the above, several series of fat determinations were made. An attempt was made to measure gas production, but the apparatus available and construction of tank made it impossible to secure accurate quantitative results.

RESULTS

A few days after the tank had been charged, the reaction of the material changed rapidly and a few times small amounts of lime were added to bring the pH value above 7.4, a total of 7½ pounds of lime being added during the first 14 days, but none thereafter. The changes in reaction during the first two months are illustrated in Fig. 1.

The screenings contain little ash and large quantities of carbonaceous materials. During the course of digestion the latter gave rise to comparatively large quantities of organic acids and CO₂, which in turn reduced the relatively high alkalinity of the ripe sludge used for seeding. After about six weeks the reaction came to an equilibrium and the pH value remained for a considerable time at 7.7.

On August 4 a beginning was made of adding 5 gallons of screenings daily, but this was discontinued after some time because it was found that the original 200 gallons had not been thoroughly digested owing to the fact that the amount of seed material used was inadequate; the amount of ripe sludge in proportion to screenings being as 1 to 12 on the basis of volatile matter, whereas ordinarily in experiments with sewage solids, a relation of 1 to 2 insures complete digestion in about 28 days at a temperature of 80 degrees. Additions of screenings were made occasionally thereafter but not until September 26 were daily charges made without interruption. These continued for 188 days, at the end of which the experiment terminated. The latter period gave the practical data useful for design, and lasted long enough to allow fluctuations in composition and concentration of screenings, which might be expected at a plant, to exert their influence.

During the former period, the percentage of ash increased gradually, corresponding to a decrease in solids, until the end of the period. The rapid rise and decline of the B. O. D. curve is an almost exact duplicate of a great number of curves obtained in

digestion experiments in the laboratory. As soon as this curve reached the comparatively low figures of 1,200 p.p.m., daily additions of screenings commenced, but they soon were discontinued for several weeks for fear the biological equilibrium would be upset.

The volume of screenings added daily during the second period was constant but the solids concentration varied from day to day as illustrated by Fig. 3, which shows the weekly averages of solids concentration throughout this period. The average for the entire 188 days was 1.7 pounds of dry solids added per day, being practically constant at 1.3 during October and increasing gradually to 2.45 in the second half of December and decreasing slightly thereafter. This is an average daily addition of 2.01% on a dry solids basis.

Studies made some years ago showed that under ordinary conditions not more than 2% fresh domestic sewage solids can be added daily, which can be increased to 3.5% under more favorable temperature conditions. Domestic sewage solids contain an average of about 25% ash or 75% volatile matter, so that on a volatile matter basis, about 2.6% can be added safely at the temperature employed in this experiment. Owing to the low ash content of the screenings, the amount of these added daily on a volatile matter basis was 2.9%.

B.O.D. AND pH.

Investigations of the past few years show that a 24-hour B.O.D. of less than 1,000 p.p.m. is indicative of a very well digested sludge, and one with a B.O.D. of less than 1,500 is fit to draw, having no odor except that associated with methane, draining and drying readily, being black in color, etc. During the first four months of this test, in spite of the increased load, the B.O.D. figures remained well below 1,000, increasing suddenly to 1,700 during the first week of February and gradually dropping back to a low figure, the increase being due to the increased load of screenings added.

The pH. value, which had been fluctuating between 7.5 and 7.7, dropped to 7.2 about 14 days before the rise in B.O.D., and began to rise with the decrease in load, followed by a drop in B.O.D. From this it appears that a daily amount of 2 pounds dry solids could easily be handled but that 2.5 pounds was above the limit. This 2 pounds is equivalent to 3.4% on the basis of volatile matter, and it appears that an increase of the daily charge from 2.6% to 3.4% could be made, or 30% more screenings could have been handled, which is equivalent to stating that 30% less digestion capacity was required than had been anticipated.

SOLID AND ASH

The average solids concentration of the fine screenings added during this period was 5.33%. To make room for the added screenings, an equivalent amount of sludge was withdrawn during the first period of the experiment, but, for fear that too much seed material would be withdrawn, most of the material withdrawn later was liquid, except for small sludge samples used for analyses. Nevertheless, the average density of the sludge withdrawn during the whole period was 3.5% as against 5.33% of the material added.

There was placed in the tank at the beginning 15.9 pounds of dry solids in seed sludge and to this was added during the total experiment 464.6 pounds of dry screenings; while the amount of sludge withdrawn plus that left in the tank at the end of the experiment was 178.4 pounds. The solids reduction of 61.6% indicated by these figures indicates that digestion had progressed rapidly and successfully. This high solids reduction was possible only because the material contained 92.1% volatile matter.

Domestic sewage solids containing 25% ash are considered very well digested when a solids reduction of 50% takes place, and 40% is considered good on a 50-day digestion schedule, and 30 to 35% on a 40-day schedule. Due to the low initial ash content in the screenings, the average ash increase in this experiment amounted to 265%.

The difference in density of the fine screenings added and the resulting sludge would seem to indicate considerable liquefaction, but a definite explana-

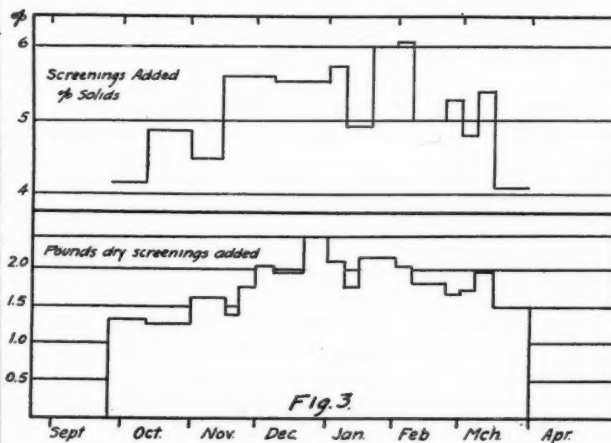
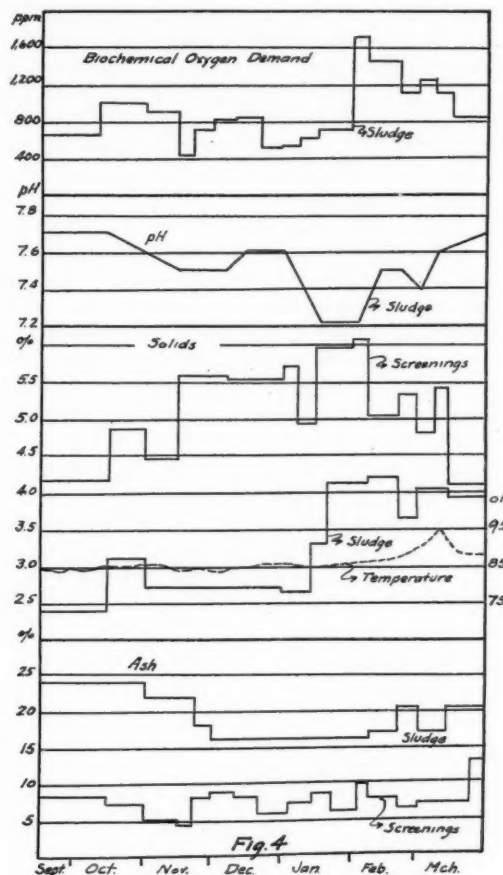
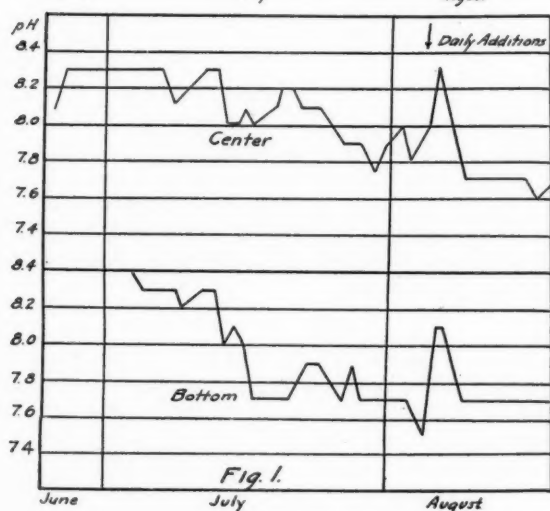
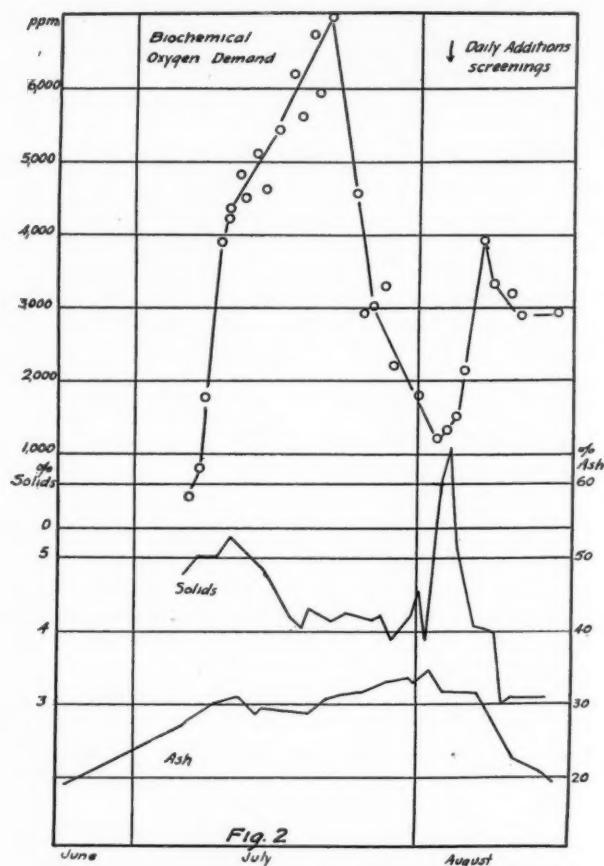


Fig. 1—Changes in pH value, during first two months digestion, in center and bottom of tank
 Fig. 2—Variations in B.O.D., solids, and ash of material during first two months of digestion.
 Fig. 3—Daily variations, in percentage solids and pounds, of dry screenings added to digestion tank
 Fig. 4—Graphic representation of analytical results (weekly averages) during 188 days daily additions of fine screenings

tion cannot be given until reliable figures on amount and composition of gases produced are available.

Table 2—Analytical Results

	Min.	Max.	Aver.
Solids added			
Solids %	4.15	8.40	5.33
Ash %	4.64	13.62	7.90
Solids drawn			
Solids %	1.88	4.47	3.50
Ash %	15.8	27.6	20.9
Liquid drawn			
Solids %	0.11	0.21	0.16
Ash %	36.1	49.7	44.4
pH sludge	7.2	7.7	7.5
B.O.D. sludge p.p.m.	440	1760	890
N as NH ₃ %			
Screenings	2.35	3.54	3.23
Sludge	2.68	3.66	3.11
Liquid	3.05	5.13	4.21
Temperature of tank, degree F.	77.1	87.4	81.0

DISCUSSION OF THE DATA OBTAINED.

The solids in the liquid of the tanks varied from 0.1 to 0.2%, showing a clear separation of liquid from sludge and scum. The ash content of the liquid was much greater than that of the sludge, nearly half of the solids in a liquid being mineral matter, mainly salts in solution. This division of the material into scum, liquid and sludge makes desirable some method of commingling the three in the tank, the method of effecting which was described by Mr. Townsend.

While a temperature of 82 degrees has been found optimum for digestion of fresh sewage solids, and it is assumed the same would be true of screenings, experiments at different temperatures are now under way to establish this point definitely.

From analyses made during December to March inclusive, the fat content of the fine screenings was found to vary widely but to average 19.3%, while that of the ripe sludge, which was more uniform, averaged 8.5%; giving a reduction of fat of 56%. Apparently the carbonaceous substances which are of a cellulosic character decomposed fastest, followed by nitrogenous substances, and finally by the fatty material, which is mostly carbon; the fibrous substances difficult to decompose being left behind as a humus-like sludge. However, the differences in rate of decomposition of the different substances were not excessive and the digestion time employed seemed to be sufficient to decompose all materials subject to rapid decomposition by biological agents.

The screenings were well digested, as appeared from the sludge which was very black, had a metallic sheen, and drained readily. Sludge placed nine or ten inches deep on an ordinary sand bed decreased in moisture content from 96.6% to 79.3% in one day and to 41.8% in 18 days, being easily spadable in 3 or 4 days. Experiments in pressing showed that when sludge with 3.83% solids was pressed for two hours a cake was produced with a moisture content of 66.6%; and in 5 hours from sludge containing 1.03% solids, a cake with a moisture of 68.9%.

DIGESTION CAPACITY

Assuming 12 cubic feet of wet fine screenings per million gallons of sewage, or approximately 750 pounds, with 100 gallons of sewage per capita per day, the per capita production of wet fine screenings would be .075 pound with a moisture content of

92%. As the experimental tank with an effective capacity of 200 gallons received a daily addition of five gallons of screenings with an average moisture content of 97%, this represents fine screenings from 205 persons if they contained 3% solids, giving about 1 person a gallon (.135 cu. ft.) of tank capacity. Since, as pointed out above, the amount charged into the tank could have been increased 15%, allowing for this would give .115 cu. ft. per capita capacity. Moreover, a digestion schedule of 30 days might be sufficient and can possibly be cut down further when more of the factors governing the digestion of fine screenings are known and the operation of the plant has been made as efficient as possible. "At present it seems that there will be no difficulty to produce good sludge at the average temperature maintained in these experiments with an effective sludge digestion capacity of .085 cu. ft. per capita. At lower temperatures the digestion capacity required will be materially increased."

Reservoir Covering Pays Dividends

An open storage reservoir of the Edwardsville Water Company, Edwardsville, Ill., was covered recently at the suggestion of the State Department of Public Health, and the advantages accruing were described by C. W. Klassen, assistant engineer of the Division of Sanitary Engineering of that department, and H. F. Ferguson, chief engineer of the division, in a paper before the Illinois Section of the American Water Works Association, from which paper the following is abstracted.

The Edwardsville supply is pumped from wells into a concrete reservoir 70 feet square at the top, with sides sloping to 40 feet square at the bottom, and 10 feet deep, with a capacity of 250,000 gallons. A wall through the center permits cleaning one half at a time.

Before the reservoir was covered, a luxuriant growth of algae necessitated cleaning it twice monthly. Copper sulphate treatment suggested by the State Department of Health was only partially successful, algae growth being still sufficient to impart objectionable tastes which were often complained of by the consumers. Also, the necessity of treating was somewhat of a nuisance to the water company. Moreover, the uncovered reservoir subjected the water supply to contamination by dust, dirt, insects, animal pollution, etc., and by workmen during the frequent cleanings. The cleaning operations not only introduced contamination, but also caused inconvenience and interruption of operation, and, because of reduced storage at times, a fire hazard.

Figures covering several years operation with the open reservoir showed that approximately \$175 was spent annually to keep the reservoir clear and free from algae growth, this figure including both labor and copper sulphate treatment.

The state department had for several years been recommending the covering of the reservoir and, following a change in ownership, the improvement was made in May, 1927. The cover is a tight, substantial plank and tar-paper roof supported on a steel frame, erected at a total cost of \$1,500.

The authors give in detail a calculation made to

show the saving effected by roofing, by comparing the total capitalized cost, and also by comparing the annual expense, before and after covering. They calculate the capitalized cost of the uncovered reservoir at \$3,500, and that of the covered reservoir (for which there would be no operating cost, but only depreciation, and cleaning once every ten years) at \$2,270; showing a saving of \$1,230 capital, or, at 5% interest, \$61.50 a year. Calculating by annual expense, they reached the same result. In this they assume the life of the tar paper as ten years, of the plank roof as 20 years, of the steel frame as 50 years.

Since covering, no complaints have been received regarding objectionable taste or odors and no algae have been noticed in the reservoir. The average

bacterial count per c.c. before covering was 129 and after covering 76.

The wells yield a water which conforms to the U. S. Public Health Service standards, but before covering the reservoir the water drawn from it did not conform to such standards, but since covering the reservoir it does conform to them.

The authors list the advantages of covering as (1) decreased inconvenience and interruption of operation; (2) decreased fire hazard; (3) prevention of objectionable odors and taste; (4) prevention of dangerous and other contamination; (5) approval of the supply by the U. S. Public Health Service for use on interstate carriers; (6) annual net saving of \$61.50; and (7) friendly feeling on the part of the water consumers.

Levee Construction Along the Mississippi River

By Major W. A. Hardenbergh*

FOREWORD.

The Mississippi flood of 1927 showed that the river bank levees were not high enough to prevent overtopping during extraordinary floods; nor of large enough section, under some conditions of soil, to prevent damage due to saturation from prolonged flood conditions. As a result, levees are being raised in some districts, and the section is quite generally being increased to equal or exceed the Mississippi River Commission standard.

Developed under previous conditions, the methods and equipment used for levee construction had become fairly well standardized, with draglines, tower machines, and teams used to a large extent on most jobs. But under present conditions and with the increased section, the amount of earth required in many localities is not obtainable within economical reach of tower machines, draglines and team haul. As a result, new methods of earth handling are necessary, and industrial railways, tractors and large-capacity trailers, and larger draglines are being used in addition to the other methods.

In a series of articles to appear this year, some levee construction jobs will be described illustrating various methods and equipment now being employed by contractors to handle earth. In this issue is described an interesting job of levee raising along the Mississippi River just north of Cairo.

Levee Construction Near Cairo

Above Cairo, where the flood problem is acute, the levee is being raised three feet. Dirt is secured from borrow pits, requiring considerable haul. Trucks and narrow-gauge and standard railway equipment are being used.

Cairo is located at the extreme southern end of the state of Illinois, at the confluence of the Mississippi and Ohio rivers. Here the flood problem is acute. The levees already are as high as they can safely be made, yet, unless some preventive is applied, the maximum flood that engineers believe possible will top these levees nearly 6 feet. With the rivers at top stage, the city is nearly 20 feet below the level of the waters. During the 1927 flood, seepage water and sand boils caused serious trouble and apprehension.

To the north of the city is low land, and in 1927 water from the Mississippi, crossing this and entering the Cache river (a small stream eight or ten

miles north of Cairo) flowed into the Ohio, completely surrounding the city. However, all levees held and, except for seep water and the troubles inherent to such tense times, Cairo came through with but a relatively small amount of damage.

Surveys and estimates have been made to determine the cost of filling the city to bring it up to levee grade, also of raising it to a height sufficient to reduce the trouble from boils and seepage. The cost of such work is very great, however, and it is probable that reliance will be placed chiefly upon the proposed floodway from Birds Point, opposite Cairo, to New Madrid, which it is expected will lower the stage at Cairo about 6 feet; but in addition to this the levees are being raised and strengthened where they are not already at the maximum grade.

The West Cairo Levee Drainage District, which lies north and west of the city, has under construction a typical levee enlargement job involving 652,000 cubic yards of earth work. The section is being raised to an average height of 20 feet over a length of about 6 miles.

The embankment carrying the M. & O. railroad has hitherto formed the levee on this section. In

*Associate Editor of PUBLIC WORKS.

the spring of 1927, the water rose so high it trickled through the ballast between the ties, but by strenuous work, failure was prevented. The enlargement now under construction will provide a crest 3 feet higher on the river side of the track.

The Missouri Pacific R. R. parallels the M. & O. about 150 feet nearer the river (but at a lower elevation). Consequently, there is not sufficient dirt available along the line of the levee, and it is necessary to bring it from borrow pits. A small borrow pit near the center of the levee line is providing dirt for about a half-mile of the work; and the remainder is being hauled from a 50-acre borrow pit about half a mile beyond the northern limit of the levee.



MAKING LEVEE EMBANKMENT BY TRUCK

Diamond T truck dumping. Nature of forest cover that had to be removed shown at left

The strip of land between the two railroads was wooded (as shown in the illustration) and it was necessary to remove the trees, including all stumps and roots, since these might later, when decayed, provide a passageway for the water.

Contract for this work was awarded to the Ward-Hayes Construction Co., Hamilton, O., at a price of 47.9 cents per cubic yard. Work was begun in late August; 185,936 cubic yards were placed in September and 137,482 in October. On November 10, when the writer visited the work, it was 55.06 per cent completed. The average yardage moved per day during the first ten days of November was 5,260.8.

Three methods of handling dirt were used on this job. A short section of the levee was sublet to Frazier and Cocke of Wickliffe, Ky., who hauled by trucks from a borrow pit over an average distance of 2,000 feet. On the remainder of the job, dirt was handled by railways. The main line of the M. & O. was used to a large extent, and was supplemented by a narrow-gauge construction railroad laid alongside the main tracks.

On the sub-contract, a Thew "Lorain 75" with a 1-yard dipper loaded the dirt into eight trucks, equipped with Wood Hydraulic Hoist bodies. There were four Diamond T trucks with 2½-yard bodies, three Dodge Brothers' trucks with 2-yard bodies, and one Model T Ford truck with a 1½-yard body, all furnished by the Robinson Transfer Company of Paducah.



THEW SHOVEL LOADING A DODGE TRUCK

These were loaded from a 5-acre borrow pit near the center of the job. Two 11-hour shifts were operated, illumination for night work being provided by Carbic lights.

The earth was gumbo, with a little sand—fine levee material—very hard and compact when dry, but soft and slippery when wet. The fill cut up under the trucks following wet weather (it was not possible to work during rains), but was kept in fair shape by frequent scraping with a Russell grader drawn by four mules.

The natural slope of the material used for fill was about 1 on 1½ and this was brought to the required 1 on 3 levee slope, on this subcontract, by means of mules and slip scrapers.



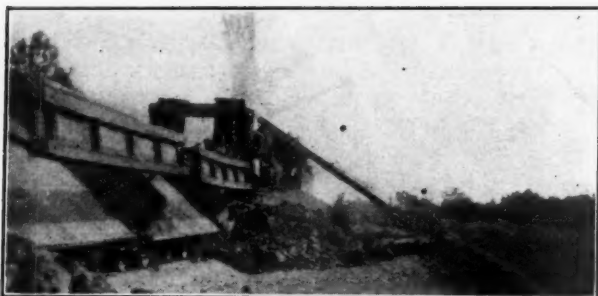
SECTION OF COMPLETED LEVEE YET TO BE SMOOTHED AND SODDED. BOTH NARROW-GAUGE AND M. & O. TRACKS AT RIGHT

The main camp which contained the headquarters and principal equipment of the Ward-Hayes Company was located at Cache, Illinois, about eight miles north of Cairo and just beyond the upper end of the job. In the 50-acre borrow pit, the contractors had a 2-yard, 50-B, Bucyrus steam shovel loading into 12-yard Western standard-gauge dump cars, and a 2½-yard Model 60 Marion railway shovel loading into 5-yard Western narrow-gauge dump cars. In addition to thirty 12-yard and thirty-nine 5-yard dump cars, and the two shovels, the contrac-



AT RIGHT—LINK-BELT DRAG-LINE CLEARING AND GRUBBING FOR LEVEE
ABOVE—PAGE BUCKET REMOVING STUMP





JORDAN SPREADER, 18 FT. WIDE, LEVELING DIRT DUMPED FROM 12-YARD WESTERN CARS ON THE MAIN LINE TRACK

Narrow gauge track is laid on this shoulder to continue the widening



FIVE-YARD CARS DUMPING FROM NARROW-GAUGE TRACK LAID ON SHOULDER MADE BY 12-YARD CARS

tor had three standard-gauge Baldwin construction, and two 21-ton Vulcan narrow-gauge locomotives. The standard-gauge equipment operated on the main line tracks of the M. & O., and the narrow-gauge on a track laid alongside the main line. Dirt was dumped alongside the track, and when it had reached sufficient elevation was graded with an ordinary railroad grader attached to an engine. On this subgrade, the narrow-gauge track was laid, and dumping continued from this until the required section was reached. No crown has yet been placed on this section.

On a part of the work, an Osgood $\frac{3}{4}$ -yard crawler shovel was used to throw over the dirt so that the full width of section could be obtained by additional dumping and spreading from the main line. In some places a combination of methods was used.

The area to be covered by the levee was overgrown with trees and brush, and clearing was an important part of the work. This was accomplished expeditiously and economically by the use of a Link-Belt crawler-mounted gasoline-driven dragline, equipped with a 50-foot boom and a Page 1-yard bucket. Sod, grass and vegetation were stripped; the smaller tree stumps were pulled up bodily by the dragline, while the larger stumps were shattered and loosened by dynamite and then removed in the same manner.

It is planned to use a similar Osgood dragline, with a 50-foot boom and a $1\frac{1}{4}$ -yard bucket, to work the sides of the fill down to the required 1 on 3 slope. The natural slope of the material used for embankment varies from 1 on 1 to 1 on $1\frac{1}{2}$, and it therefore is necessary to grade as well as dress down and sod the levee.

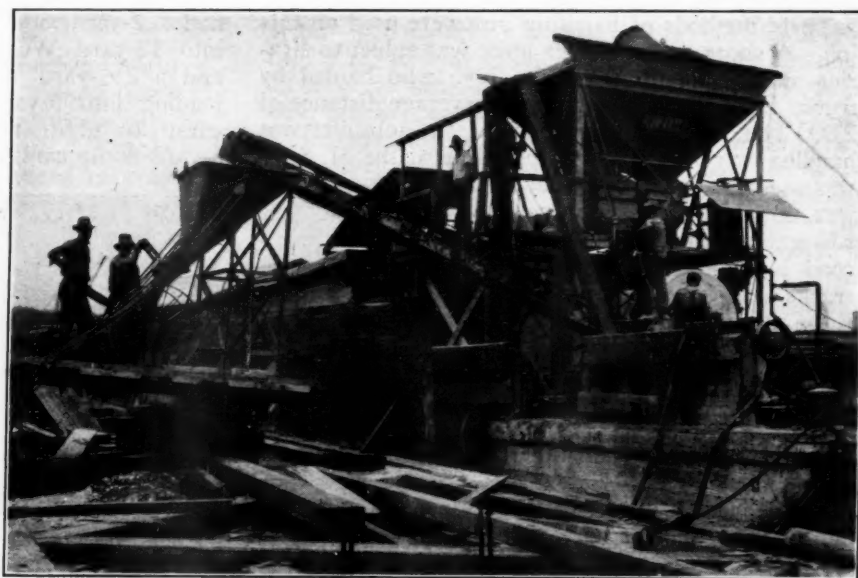
At the time of this inspection the Ward-Hayes Co. had about 240 men on the job, and was working them in two shifts of about 10 and 8 hours.

Mr. Hayes is in direct charge of the work. Wm. A. Steel is inspector in general charge of the work, which is being done under direction of Major L. B. Chambers, in charge of the First Field Area of the Memphis Engineer District of the Mississippi River Commission. Clyde M. Hogue is inspector and Willis Chapman assistant inspector on the work. Completion is scheduled for December 31, 1928, but it is likely that some additional time will be required to finish the work.

Concrete Work in Baltimore Harbor

The city of Baltimore is building a harbor terminal at Locust Point which will probably cost more than \$6,000,000 and involves driving 50,000 piles from 35 to 90 feet long. Upon completion, the plant is to be leased by the city to the Western Maryland Railroad.

One of the piers containing the deepest piles, most of them 90 feet long, is being built by the Merritt-Chapman and Scott Corp. In placing the concrete, which consists of outside walls, center walls, and column pedestals, this company has developed a very efficient concreting plant which, as the pier is surrounded on three sides by water, is mounted on barges. The plant on the mixing and placing barge consists of a Blaw-Knox batching hopper and one-yard stationary drum mixer, cement shed, Haiss cement elevator to a mixer loading platform, and Haiss portable belt conveyor for placing the concrete. The mixer is mounted high enough to



MIXING PLANT DISCHARGING CONCRETE INTO HOPPER

deliver into a concrete hopper above the belt conveyor so as to control the flow of concrete onto the belt. The loading platform is placed at a height convenient for emptying cement bags into the mixer loading hopper, and the measuring hoppers of the batching plant discharge direct into this hopper.

The cement is wheeled from the cement house to the foot of the cement bag elevator, and is carried by hand from the head of the elevator to the loading hopper.

Sand and gravel are delivered in divided barges which are kept moored alongside, as the storage capacity of the batching plant is nominal, only enough probably for one hour's run. A derrick barge equipped with a clam-shell bucket puts the sand and gravel in the batching plant hoppers and is available for warping the concreting barge along the pier.

The portable belt conveyor used is a standard troughing type from which the wheels and carriage have been removed, and is suspended by a chain block from an A-frame at the side of the barge. It is driven by a two-cylinder Le Roi engine mounted over the elevator frame. A scraper of rubber belting is placed normal to the conveyor belt just below the head pulley, and the flashing at the loading end has been made higher and two holes put in the frame at the loading end to facilitate hoisting the belt and pulley.

The concrete is made to specifications calling for 1 minute and 30 seconds in the drum; a batch of $\frac{7}{8}$ yard to 1 yard being turned out every two minutes, and delivered by the conveyor in from 35 to 50 seconds. The concrete has a sticky consistency, dry enough to meet the approval of the engineers and wet enough to flow around reinforcing steel and be spaded easily. In order to prevent segregation caused by falling on the reinforcement, the concrete is discharged at the head of the conveyor into a

tremie. The conveyor has carried concrete up slopes as steep as 30 degrees without any increase in spilling. The entire belt and conveyor are thoroughly hosed down at least twice a day.

The force on the barges includes one man on the gravel barge, two men handling cement, the crane-man, the mixer operator, one man at the concrete hopper and one man cleaning up. Ashore there are two men at the conveyor and one man spading the forms. The output averages 200 yards per 8-hour day.

Sampling and Testing Highway Materials

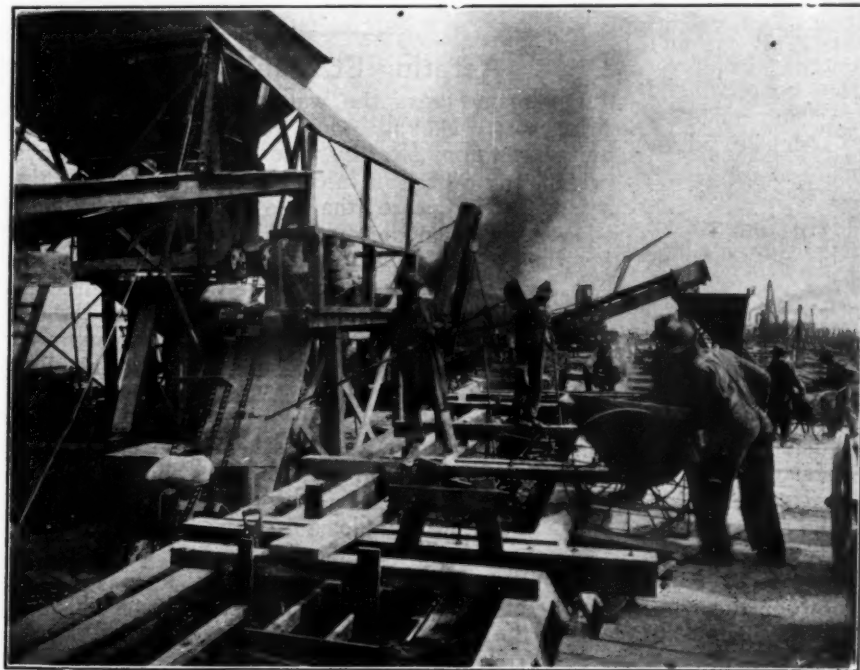
Tentative Standard Methods Adopted by Association of State Highway Officials

The U. S. Department of Agriculture has recently published a bulletin, Department Bulletin No. 1216 Revised, giving "tentative standard methods of sampling and testing highway materials" adopted by the American Association of State Highway Officials and approved by the Secretary of Agriculture for use in connection with Federal-aid road construction, including revisions adopted prior to August 1, 1928. A previous bulletin with this same number was published in May, 1924, but a number of revisions have been made since then, which are included in the present edition.

In preparing these standard methods, the association, whenever possible, has adopted without change the existing American Society for Testing Materials' standard or tentative standard methods. In a few cases, slight changes in wording have been made, which are indicated in this bulletin by bracketing or by italicising. In other cases, the methods are based on those of the A. S. T. M., but differ considerably from them in phraseology; and in other cases the methods are not similar to or are additional to those of the A. S. T. M.

The methods which are identical with those of the A. S. T. M. or have only minor changes of wording therein are as follows:

Methods of sampling and testing portable cement. Methods of sampling stone, slag, gravel, sand, and stone block for use as highway materials, including some material-survey methods. Test for abrasion of broken stone and broken slag. Test for toughness of rock. Test for quantity of clay and silt in gravel. Decantation test for sand and other fine aggregates. Test for apparent specific gravity of sand, stone, and slag screenings and other fine non-bituminous highway materials. Test for field determination of approximate apparent specific gravity of fine aggregate. Test for field determination of approximate percentage of voids in fine aggregate. Test for field determination of surface moisture in fine aggregate. Test for unit weight of aggregate for concrete. Test for determination of voids in fine aggregate for concrete. Test for organic impurities in sands



CEMENT BAG ELEVATOR, LOADING PLATFORM, BELT CONVEYOR.
CONCRETE BUGGY DUMPING CONCRETE INTO FORMS

for concrete. Making compression tests of concrete. Making and storing compression specimens of concrete in the field. Securing specimens of hardened concrete from the structure. Test for sieve analysis of aggregate for concrete. Mechanical analysis of sand or other fine highway material. Mechanical analysis of coarse aggregate. Testing brick. Sampling and testing drain tile. Sampling bituminous materials. Test for loss on heating of oil and asphaltic compounds. Tests for flash and fire points by means of open cup. Test for penetration of bituminous materials. Float test for bituminous materials. Test for ductility of bituminous materials. Test for distillation of tars and tar products. Test for softening point of bituminous materials (ring and ball method). Test for water in petroleum products and other bituminous materials. Testing bituminous emulsions. Sampling an analysis of creosote oil. Test for coke residue of creosote oil. Test for distillation of creosote oil. Determining weight of coating on zinc-coated articles. Verification of testing machines. Tension testing of metallic materials. Compression testing of metallic materials. Brinell hardness testing of metallic materials.

Methods different from the A. S. T. M. standards are as follows:

Test for abrasion of gravel. Test for toughness of gravel. Determining quality of glacial gravels by lithological count of particles. Test for quantity of soft pebbles in gravel. Test for soundness of coarse aggregate. Test for percentage of shale in aggregate. Test for apparent specific gravity and absorption of stone and other coarse materials. Test for apparent specific gravity and absorption or free moisture content of sand, gravel, stone, or other non-bituminous highway materials. Test for absorption of concrete. Test for quality of water to be used in concrete. Mechanical analysis of extracted aggregates. Sampling paving brick. Making compression and tension tests of fine aggregate for concrete. Sampling mineral filler. Determination of fineness of mineral filler. Proportioning natural sand and gravel for concrete construction. Tests for wire rope. Sampling bituminous mixtures. Sampling and testing premolded joint fillers. Testing for specific gravity of bituminous materials. Test for percentage of bitumen soluble in carbon disulphide. Test for percentage of bitumen insoluble in carbon tetrachloride. Test for percentage of bitumen insoluble in paraffin naphtha. Test for specific viscosity. Test for percentage of residue of desired penetration. Calcium chloride methods for determination of percentage of water in bituminous emulsion. Examination of bituminous mixtures. Sampling and testing wood block. Test and inspection of corrugated metal culverts. Test for uniformity of galvanizing or spelter coating on wire.

The method of testing cast iron, concrete and vitrified clay culvert pipe is that recommended by the Joint Concrete Culvert Pipe Committee in its report of February, 1926.

Airports As Public Utilities

Nearly eight and a half million dollars of public funds was voted for airports at the November 6 elections. Eleven cities or counties passed bond issue propositions ranging in amount from five million voted by Detroit to \$25,000 approved by the people of Albany, Oregon. During the past year appropriations or bond issues have been passed which involve nearly \$21,000,000, all to be spent in supplying cities and counties with airport facilities. The addition of these to the public airports already in existence indicate beyond doubt the status of airports as a public utility. The Supreme Court of Missouri has ruled that the airport is a public utility, in passing judgment upon the validity of airport bonds voted by St. Louis and Kansas City.

The airport is popular with all classes of citizens. At Columbus, Ohio, organized labor worked as hard for the passage of the airport bond issue as any

group of capitalists. This probably is largely due to the possibilities of work for all classes of labor. Administration buildings are furnished which equal modern railway terminal buildings in size and usefulness. Lighting equipment, air weather bureaus, fire-safe hangars, and paved runways are but a few of the features which have become commonplace in the designing of airports.

Dead Ends in Water Distribution Systems

A discussion on this subject was held at the San Francisco convention of the American Water Works Association, at which S. B. Morris, chief engineer of the Pasadena, Calif., Water Department, presented a paper which he summed up in the following conclusions:

"From the above discussion we must conclude that dead ends are something we should restrict to an absolute minimum in any modern water works distributing system, for such dead ends tend to decrease pressures, lessen fire flows, increase shutdowns, increase water hammer, increase complaints of tastes and odors, and in some cases they may increase corrosion, particularly from electrolysis. The growing use of duplicate mains on each side of a street should make the number of dead ends between pressure districts less necessary. In fact this is an additional argument for such duplicate mains.

"The practice of locating fire plugs on dead ends as effective bleeders for the mains is desirable in flushing the pipe lines, but not so satisfactory from the standpoint of fire protection.

"For average water conditions sealed services should present no greater problem than active services. Where severe conditions are known to exist, sealed services can be installed with the corporation cock at the main closed, and a valve box installed over such cock so that the service can be turned on when required. In this way water is not turned into the service until it is to become an active service. This is the present practice in some cities."

Aerating St. Paul's Water

For many years the water supply of St. Paul, Minnesota, had an odor variously described as musty, swampy, earthy, etc., which was always present but varied in intensity and quality with the seasons. It appeared that the odor was most likely to increase when the dissolved oxygen content was low, and assuming an intimate relation between the two, in the summer of 1926 the water commissioners installed an air compressor in the plant for the aeration of the entire supply; with the result that complaints from odors have been practically eliminated.

Air is applied at the rate of 6,000 cubic feet per million gallons of water which, on the basis of 20 per cent of oxygen in the air, gives about ten parts of oxygen per million of water. The air is diffused through the water under a pressure of 5 to 6 pounds per square inch. The estimated cost is about 50c per million gallons.

The effect of the aeration is not only to add oxygen to the water, but also apparently to drive out the gases from the water by the agitation; the odor of these gases being noted above the surface of the water during the season when the odor is highest.

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Public Work in 1928

The year 1928 saw no falling off in the enormous amount of public works being constructed in the United States, and in quality of work some progress was evident. As in 1927, highway work constituted more than half of all the public work performed, measured in dollars spent. The prospects are that 1929 will fully equal 1928 in both quantity and quality of work done.

We present in this issue a general review of last year's work, prepared by men prominent as engineers or in state and federal highway and contracting organizations, and in position to give full and reliable information on the subjects they discuss. We believe our readers will appreciate this bird's eye (or airplane) view of the road over which we have progressed during the past twelve months. As road work consumed more than one and a quarter billion dollars during the year and the science and technique of it are still making notable progress, it naturally occupies a large part of the space given to this review of the year's work. Especially noticeable is the prominence given by the reviewers to the use of equipment as a means both of saving labor and of improving the quality of the work.

Construction on the Mississippi

From Cairo to New Orleans, over a stretch of a thousand miles, flood control activities along the Mississippi have been at a high pitch during the past months. Notwithstanding the lack of agreement on some of the important points of the adopted plan of flood control, a tremendous amount of work is going on. Local levee districts are enlarging and raising levees, and making setbacks where the river is encroaching on present levees.

Construction methods and construction machinery are not yet standardized. Enlarged levee sections, and greater heights, necessitating an increased amount of dirt and a consequent increased length of haul, have brought new problems in earth handling. Tower machines, and other specialized equipment, as well as the time honored mule, are less in evidence than hitherto. Large draglines on the lower river, and tractor-trailer combinations and smaller draglines elsewhere are being used largely.

Engineers on the river are looking forward to other methods, too. Hydraulic dredges are now being tried out in one or two places. They are capable of moving large yardages cheaply and where the levees are fairly close to the river, may prove economical. Draglines, especially those capable of handling 4 to 6-yard buckets, are moving earth about as cheaply, if not more so, than other equipment. Tractors and trailers with elevating graders are being used by a number of contractors with success.

In forthcoming issues, several levee construction jobs will be described, bringing out the performances of the various types of equipment. These, which we believe will be of unusual interest and value to reader, contractor and equipment manufacturer, will be supplemented from time to time by special articles prepared by engineers engaged in flood control work.

Water Supply, Sewage Treatment and Refuse Disposal in 1928

By H. Burdett Cleveland*

WATER SUPPLY

General. The most important activity in public water supply work, as in 1927, and as relating to privately owned systems, has been the purchase by holding companies of additional water supply properties and groups of properties throughout the country, but principally in the east, south and southwest.

This more intensive movement for the consolidation of public water supply systems has been under way for about three years. Four of the eight principal holding companies now own a combined total of over two hundred individual systems. Several of these companies have been operating water supply utilities for many years with no general expansion of their business until recently. Five of the holding companies were formed during the past three years, one of them having been incorporated during the past year.

This development in the water supply field has brought forth renewed discussion as to the relative merits of public and private ownership of public water supply utilities, the obvious benefits and economies of centralized control and management being valuated against the possibilities of inadequate rate control and over-capitalization.

Continued attention has been given to reforestation of watersheds from which public water supplies are derived. In New York State, for example, the area of plantings reached a total of over 20,000 acres in 1928.

Steps were taken by the American Water Works Association during the year to facilitate a revision of "Water Works Practice," a manual first issued by the association in 1925. At meetings of the various state and local sections discussions have been arranged to aid in amplification and revision and the balancing of the treatment accorded the many phases of this branch of engineering.

The principle established through many typhoid fever epidemics, that polluted industrial and auxiliary fire supplies should not be cross-connected to potable water supply systems received added recognition during the year by the enactment of additions dealing with this subject to the sanitary codes of several states.

A ruling of the New York State Department of Health with reference to the provision of the Sanitary Code prohibiting such cross-connections after July 1, 1928 states, as a final notice, that the existence of a cross-connection between a potable public water supply and a non-potable auxiliary industrial or fire supply after January 1, 1929 will be illegal. Provision is made in this ruling that in the case of auxiliary supplies which are not too grossly pol-

luted, cross-connections may be allowed under certain conditions provided the municipal supply is protected by automatic, continuously operated chlorinators and by double check valves of the all-bronze type.

On September 18, 1928, the New Jersey State Department of Health added a section to the State Sanitary Code prohibiting such cross-connections from polluted supplies after April 1, 1929 except in compliance with strict regulations.

Increased adoption of copper and brass service pipes has been noted through the year. At the Superintendents' Round Table during the annual convention of the American Water Works Association, twenty-six cities reported the satisfactory use of copper services, while thirty-eight cities reported no experience.

General problems of water supply design and construction have engaged the attention of committees throughout the year, such as the relation of industrial waste discharge to filter plant operation, and the desirability of a standard form of contract, together with questions of detailed construction features.

Considerable attention has been focused on the formulation of interstate river compacts, the need for such agreements being emphasized by expanding requirements for additional sources of supply as well as by increasing pollution of waterways.

Completed and Projected Improvements. An unusually large number of major water supply projects are under construction or are being planned.

In November a contract was let by the City of New York for the construction of a seventeen-foot tunnel twenty miles long to serve as a second pressure aqueduct to convey Catskill water from Hill View reservoir in Yonkers to Brooklyn. It is expected that this tunnel will be completed in about six years and that, eventually, it will be extended to Staten Island at an additional cost of \$19,000,000. The present contract, which covers the four sections, amounts to nearly \$45,000,000 and is the largest single contract ever awarded by the City of New York.

After considerable uncertainty regarding the final design of the Wanaque aqueduct, to be constructed by the North Jersey Water Supply District at a cost of about seven million dollars for conveying water from the new Wanaque reservoir to Newark and seven other New Jersey municipalities, plans were adopted on which bids were received on December 20th.

Construction work was started on May 5 for a new water supply system for Albany, N. Y. The present source of supply, by pumping from the Hudson river followed by filtration, will be

*Consulting Sanitary Engineer, New York City.

abandoned for an upland gravity source southwest of the city which will require a twenty-mile conduit.

Water supply improvements are being carried out at Baltimore under a \$10,000,000 bond issue authorized in 1927. Additional mains and improvements at the Mount Royal pumping station will constitute the bulk of the work.

As a sequence to the failure of the St. Francis dam, a board of engineers and geologists has been appointed to make a complete survey and investigation of the Los Angeles water supply system.

Other major projects under way or proposed are:

The Hetch Hetchy aqueduct, 17 miles of which is practically all tunnel, is nearly completed. This aqueduct will have a total length of 156 miles from O'Shaughnessy dam in Yosemite National Park to the San Francisco distributing system. On May 1st, San Francisco voted \$65,000,000 in bonds, \$24,000,000 to complete the aqueduct and \$41,000,000 to purchase private distribution systems.

The East Bay Municipal Utility District has been formed by nine municipalities, including Oakland and Berkeley, on the eastern side of San Francisco Bay opposite San Francisco, and is constructing what is known as the Mokelumne project at a total cost, including the construction and acquisition of local distributing systems, of \$65,000,000.

Extensive developments to obtain additional supply for New Haven are being carried out by the water company.

At Milwaukee, studies are being made for additional water supply facilities and as to the future need of a filtration plant to treat the supply which is derived from Lake Michigan.

Considerable progress has been made on the \$65,000,000 Swift and Ware rivers project of the Boston Metropolitan district.

At Springfield, Mass., an additional pipe line from Provin Mountain reservoir across the Connecticut river to the city is nearly completed.

Additional water supply for St. Louis is being provided by the development of a new intake source along the Missouri river. It is expected that the new plant, which includes filters, will be completed early in 1929.

Treatment. It is apparent that the pace in investigation and research work with reference to water supply treatment has increased during the past year. Intensive study is being given at many points, notably at Baltimore, at Toronto and at Chicago, to the improvement of filter plant operation and to the determination and proving of changes in processes intended to effect economies and to bring about still more effective purification.

At Chicago an experimental plant costing \$150,000 has been constructed and placed in operation during the past year to permit extensive studies for determining the most efficient and most economical method of purifying the entire supply for the city. The supply,

drawn from Lake Michigan and treated at present by chlorination alone, averages 875 million gallons daily. A filter plant for the city would probably be designed for a capacity of at least one billion gallons.

In view of the close study given recently at many filtration plants throughout the country to improvements in processes, to changes in the character and application of chemical reagents, and to details of filter design and operation, it is to be expected that research work at the Chicago experimental plant will produce authoritative results, will consolidate the gains in methods lately made or indicated and, so far as such results may be generally applicable, will be of widespread benefit to the art of water purification to a degree more marked than has resulted from any similar work since the experiments at Louisville, Washington, and New Orleans of 1895 to 1901.

Experimental work has been continued during the year at several plants with regard to aeration for the removal of tastes and odors and for reduction of the corrosive agent, CO_2 ; the application and testing of new coagulants to be used alone or in connection with alum; prevention of corrosion by saturation of the water with calcium carbonate and by preliminary dosage with soda ash; the benefits of returned sludge in water softening processes; and along many other lines. The object of much of this experimental work is the improvement of the physical characteristics of public water supplies, a requirement of real importance and more insistently demanded of late, although secondary to the insurance of bacterial purity.

Chlorination developments and progress in chlorine application have consisted principally in the increased number of instances where chlorine is being applied to the raw water before filtration; the wider use of chlorine to reduce algae growths; in experiments, first carried on at Toronto, to correct phenol tastes through super-chlorination and subsequent dechlorination; and in experiments in pre-chlorination to effect economies in the use of coagulants, to reduce the safe limit of residual chlorine and to increase the effectiveness of sterilization.

Developments in filter design and operating improvements have not indicated any real changes in filter layout, but have embodied principally the growing adoption of mechanically cleaned sedimentation basins, renewed experiments in washing filters by sections, and refinements in chemical mixing facilities.

Typhoid fever reduction has continued to a point which has brought forth optimistic predictions of its being wiped out, eventually. Records for 1928 were of course not available at the end of the year, but during 1927, for 50 weeks, total cases in 36 states were 22,400 as compared to 25,500 in 1926 and 30,700 in 1925, according to the U. S. Public Health Service. Typhoid fever deaths may safely be said to be reduced in about the same proportion. For 74 cities reporting in 1910 as well as in 1927, representing a population of 22.3 millions in 1910 and 32.5

millions in 1927, the death rate per 100,000 from typhoid fever declined from 20.59 to 1910 to 1.96 in 1927. Water supply filtration and chlorination has been largely responsible for this reduction and for the continued suppression of high mortality from this disease.

SEWAGE TREATMENT

General. Added impetus will be given the movement to restrict sewage pollution of waterways (a movement which has been distinctly gaining ground in recent years) by the important and definite steps in this matter taken during the year by the City of New York. On August 15, the Board of Estimate and Apportionment authorized an expenditure of \$18,500,000 for the proposed new sewage treatment plant on Ward's Island. The decision to construct this plant has resulted from a study of the problem for twenty-five years and, more particularly, from a recent study of the entire question made by the comptroller and the chief engineer of the board, assisted by the sanitary engineer and by the consulting engineer on sewage disposal. The plant will have an initial capacity of 180 million gallons daily, to be contributed by parts of Manhattan and the Bronx.

A more comprehensive step proposed is the establishment of a sanitary commission for the city to have charge of all waste disposal, including design, construction and operation of all plants and sewers.

Constructive advance in sewage treatment is being shown, also, by the continued progress that is being made in several states in providing for and carrying out joint sewerage and sewage treatment projects. It is becoming generally recognized that the treatment of sewage from any certain district, if total expenditures for this purpose are to be made along sound engineering lines and with greatest economy, must be planned on the basis of topography and natural drainage areas, so far as practicable, and not by civil divisions. Lessened cost for main trunk sewers, reduced number of disposal plants and more effective treatment of sewage result from such cooperation. In this connections it may be noted that a substantial beginning has been made during the year in the construction of a series of joint sewerage and sewage treatment projects for Westchester County, N. Y., an outstanding example of the wisdom and of the applicability of such joint action.

Joint action along administrative lines for control of steam pollution has been exemplified within the past fifteen months by the establishment of the first "de facto" river board in the United States. The "Board of Public Health Engineers of Ohio River Basin," set up for preventing pollution of the Ohio river, is composed of representatives from Pennsylvania, Ohio, West Virginia, Kentucky, New York, Maryland, Illinois, Indiana and Tennessee.

The special master's decision rendered a year ago, upholding the permit granted by the Secretary of War to the Chicago Sanitary District for the diversion of 8,500 second feet of water

from Lake Michigan to the Mississippi river system to increase dilution of Chicago's sewage, contemplates adequate treatment of the sewage and points out that the permit is revocable at any time for cause. This decision, with its sound and clear presentation of the underlying principles involved, denies the claim of power to establish, except as a temporary measure, prescriptive rights to stream pollution and should aid in placing responsibility for nuisance and water pollution abuses on the proper authorities at other points.

The administrative problem of stream protection in the United States is at the beginning, only, of its solution. In 1915, Metcalf & Eddy estimated that 84 per cent of sewage was being disposed of by dilution. By 1923, the Public Health Service estimated that over 82 per cent of sewage was still being discharged without any treatment. While many large sewage treatment plants have been placed in operation since 1923, and especially during the past year or two, as at Chicago, Milwaukee, Philadelphia, Indianapolis and Los Angeles, increased population tributary to sewer systems in cities which have not constructed sewage treatment plants has undoubtedly resulted in comparatively little reduction, as yet, in the percentage of sewage discharged into streams and bodies of water without treatment.

Increased public interest in the prevention of stream pollution, the more definite action being taken by State Departments of Health in requiring sewage treatment, and the assumption of proper responsibility in the matter by municipal authorities throughout the country, point to considerable progress in the near future in these necessary sanitary measures.

Plant Construction. Many very large sewage treatment plants are being constructed or planned and several large plants have been completed and put in operation during the past year.

On October 3, the North Side sewage treatment works were put into use by the Sanitary District of Chicago. This is the largest activated-sludge plant so far constructed and is designed for a population of 830,000 in 1930 and a population of 1,013,000 in 1940. The total cost of the plant, including land and engineering, was about \$19,000,000.

The West Side sewage treatment plant at Chicago is being built rapidly under advanced methods of construction, which include precast concrete slabs in place of poured concrete or gunite baffle walls. A battery of 36 Imhoff tanks is being installed with provision for two additional batteries of 36 units each in the future. The entire plant will have a capacity for a population of 1,850,000 in 1940.

Until other methods of sludge disposal have been developed or adopted at the North Side plant, the excess activated sludge from this plant will be pumped through a 14-in. cast-iron force main 18 miles long to the Imhoff tanks of the West Side plant for digestion and for drying on open sludge beds.

The new plant on Ward's Island for New York

City will use the activated-sludge method. Possible future locations selected for additional plants of this type are at Jamaica, at Sheepshead Bay and at Hendrix St., Brooklyn. It is significant and of interest to note that, even with no potable water supply protection involved, the proposed new plant is of a type to accomplish complete treatment.

The third large sewage treatment plant for Cleveland, the southerly sewage treatment works, is being completed at a general contract cost of \$2,659,111. The outfall section of the intercepting sewer cost \$220,695. This plant consists of screen and grit chambers, a battery of 24 Imhoff tanks and six acres of sprinkling filters, together with humus or final settling tanks and glass-covered sludge beds, the cost of the latter not having been included in the general contract. The plant has been designed for a capacity to serve a population of 280,000 in 1940, with provision for extension in the future to serve a population of 1,250,000.

Interesting provision for sewage treatment at Springfield, Ill., consists in the construction of 17 miles of marginal intercepting sewers.

The Indianapolis treatment works are being enlarged at a cost of \$260,000.

Buffalo has appropriated funds for the design of intercepting sewers and sewage treatment works.

The new sewage treatment plant at Akron, Ohio will be put in operation early in 1929. This plant consists of 24 Imhoff tanks, 14 acres of sprinkling filters, final settling tanks and four acres of sludge beds and cost \$3,750,000.

At Columbus, Ohio a new interceptor and extension of the sewage treatment plant are under construction.

An increased number of smaller plants have been constructed during the year, many of these to replace inadequate or inefficient earlier plants.

Developments in Processes. Experiment and research in sewage treatment processes have been continued at Lawrence, at New Brunswick, at the Harvard Engineering School and at various plants throughout the country. Research work has been started at the Sewage Research Laboratory of the Texas Engineering Experiment Station at the Agricultural and Mechanical College of Texas.

Considerable work has been done at Milwaukee and at New Brunswick to determine the feasibility of digesting sewage screenings with sludge. Continued study has been given, also, to sedimentation and to sludge digestion at separate sludge digestion plants and at New Brunswick.

A very interesting summary, in brief form, has been furnished by Dr. Willem Rudolfs, chief of the Department of Sewage Disposal at the New Jersey Agricultural Experiment Station, New Brunswick, N. J., giving the results and conclusions reached by the laboratory work during the past year. These conclusions, naturally, epitomize, to date at least, the very important research work carried on at this station for several years, and are as follows:

1. Odors in sewage sludge digestion are caused mainly by hydrogen sulfide.

2. Fine screenings do not affect the digestion of sewage solids materially, either when substituted as part of fresh solids or when digested separately with ripe sludge.

3. Vegetable wastes retarded digestion considerably when digested separately or in combination with fresh solids.

4. There is a narrowing of the carbon-nitrogen ratio in the course of digestion, due to the elimination of carbon in the form of gases, while nitrogen is lost only to a limited extent.

5. Changing the carbon-nitrogen ratio of digesting mixtures by the addition of substances like filter paper, casein and oil retards the rate of digestion.

6. Fats are destroyed in the course of digestion of fresh solids. The rate of destruction is dependent on factors like temperature, seeding, reaction of material, etc.

7. Sodium chloride up to 250 p.p.m. does not affect the rate of digestion, while up to 500 p. p. m. the rate of digestion is but slightly retarded.

8. Certain trade wastes like sulfuric acid, dyes, sodium hydroxide and iron sulfate affect digestion to a limited extent.

9. Bacteriological studies on the effect of lime and temperature on digestion have shown that there is no relation between total numbers of bacteria and the specific physiological groups and the rate of digestion.

10. A simplified method to determine the hydrogen ion concentration of digestion tanks has been worked out.

11. The age of ripe sludge is a factor in seeding. Very old sludge is inferior for seeding to active gasifying material.

12. Freezing of fresh solids, ripe sludge or fresh solids—ripe sludge mixtures affect digestion only slightly.

13. High solids concentration retards digestion, but the retardation is not proportional to the solids content.

14. Slow stirring in tanks seems to be beneficial to digestion.

15. The determination of volatile acids as applied to digesting solids have shown that there is a correlation between the volatile acids and the general course of digestion.

16. Odors emanating from sewage disposal plants can be controlled by the use of chlorine applied during certain hours of the day in the summer months.

17. Sedimentation tests at five different separate sludge digestion plants were made, showing considerable variation of the same type of plant, due to local influences, like trade wastes, etc.

18. There is a difference in composition and a difference in decomposition of fresh solids settling in different parts of a settling tank.

19. Plant experiments showed that with proper seeding, heating and reaction control, a digestion schedule of about 40 days can be maintained.

20. Plant experiments on the effect of heating the sludge have shown conclusively that temperature is one of the most important factors in sludge digestion.

21. Large scale experiments have shown that as high as 0.64 cu. ft. of gas per capita per day can be produced.

An analysis of effective proportions and operating arrangements of settling tanks for greatest efficiency in deposition of solids has continued to claim attention during the year.

The aeration of sewage in the activated sludge process by mechanical agitation at the surface of flow in the tanks is being adopted to some extent and studied with a view to reducing the operating cost of this very effective process.

Removal of gas from Imhoff tank gas vents by vacuum and the consequent control of odors and a reduction in the accumulation of scum and of foaming has been reported.

Continued tests have been made at various treatment plants with respect to the application of chlorine for disinfection of sewage and effluent, and also for control of odors. Some of the objects of such studies have been to re-

duce total required dosage by pre-chlorination, to determine seasonal and daily requirements for continuously effective chlorination with the object of reducing the cost for chlorine, and lessening the clogging of filters.

San Bernardino, Cal. is constructing a plant including sprinkling filters with pre-chlorination, after a careful comparison between the probable cost of the plant under construction and an activated sludge plant, and with the special object of insuring absence of odor nuisance.

Pre-chlorination for disinfection at the Imhoff tank installation at Portsmouth, Ohio, is being continued as during the past three years.

Pre-chlorination with special reference to odor control is also being employed at Schenectady, N. Y.; at Plainfield, Totowa and Haddonfield, N. J.; San Bernardino and Newport Beach, Cal.; Independence and Neodesha, Kan.; Virginia Beach, Va.; Greenville, Tenn.; Jacksonville and Kerrville, Tex.; Las Cruces, New Mex., and at other points.

A review by the Chlorine Institute of reports of studies and plant operating data in the matter of reduction of B. O. D. as the result of chlorination shows a true reduction varying from 20 per cent. to 35 per cent., as evidenced by reports from Cleveland and Columbus, O., Dallas, Tex., Chapel Hill, N. C., New York City, New Brunswick, N. J., Schenectady, N. Y., Harvard Engineering School, Huntington, L. I., and other points.

It is also reported that chlorination is to be used in at least two plants to secure the partial reduction of oxygen demand, thus deferring secondary biological treatment.

Chlorine has been applied successfully at two points along the 26 mile outfall sewer in Orange County, Cal. This procedure has proven to be economical and feasible with respect to control of odors from manholes and from the screening plant, and, incidentally, it has become apparent that any tendency to disintegration of the sewer will be decidedly checked.

Sludge disposal continues to present more problems requiring further study than any other feature of sewage treatment. This is naturally the case, since the removal of suspended solids in sewage, which when settled form sludge, constitutes the principal reason for the genesis and the greatest incentive for the further development of the art of sewage treatment. Intensive study is being given to what was at first but is no longer considered a side issue—the problem of economically handling and disposing of sludge in a sanitary manner.

REFUSE DISPOSAL

General. Activity in municipal refuse disposal has continued in 1928, principally in the construction of refuse incinerators for comparatively small communities. Few large plants of 100 tons or more daily capacity have been built or contracted for, although several are under consideration. From the records available, however, it appears that 19 plants of 20 to 60 tons capacity have been installed, in several instances

to serve a present population of 5,000 and under, and it is probable that an increased number of incinerators for small municipalities will be constructed during 1929.

The adoption of incineration as a means of disposing of the rubbish and garbage from so many of the smaller towns and villages reflects the increasing difficulties met in securing isolated dumping or hog feeding sites, even for very limited daily collections.

Many of the smaller projects are made possible from an economic standpoint by cooperative action between communities or by the service given by one community in the incineration of refuse from other communities at an agreed charge per ton.

Detailed consideration was given at the annual convention of the International Association of Street Sanitation Officials to the subject of refuse collection and disposal. The committee report summarized the essential features of an efficient garbage collection and disposal system, in the order of their importance, as follows: (1) sanitation; (2) service; (3) economy; (4) dependability and flexibility; and (5) expediency; and emphasized the necessity of care and technical study in the selection of the type, arrangement and capacity of plants, which should be governed by the characteristics of the refuse as affected by climate, season and population, and by the sites available, topography, markets for possible products and existing facilities.

Plants. Incinerators of 100 tons or more capacity per 24 hours were constructed or contracted for at Yonkers, N. Y., Norfolk, Va., Houston, Tex., Louisville, Ky., Elmira, N. Y., Brooklyn (3), Queens Borough, New York (3) and Syracuse, New Orleans, (3).

At Chicago a 600-ton incinerator, built at a cost of \$600,000, was put in operation in June.

At New Orleans a contract was let for three refuse incinerators, two with capacities of 165 tons in 16 hours and the third a 50-ton plant.

An appropriation of \$5,000,000 was recently made by the Board of Estimate and Apportionment of New York City for four new refuse incinerators in Manhattan and the Bronx.

Final decision has not yet been reached as to the construction of the proposed reduction plant at Cleveland. This plant, which is the only garbage reduction plant recently planned, if constructed, will be the first plant to combine with reduction, incineration of a portion of the residue along with rubbish.

RÉSUMÉ

Increased understanding by the public and more definite support from the press of sanitary improvement programs has been apparent throughout the past year. Cooperative action and the trend toward the formation of joint sanitary districts has also been noteworthy. The formation of the Federation of Sewage Works Associations and the correlation of several lines of water supply research during the year give promise of still greater development in the art of sanitary engineering.

Stream-Flow Aeration of Sewage

Description of a substitute for the activated sludge tank developed during 1928 for treating packing house waste.

"Stream-flow aeration" is the name given to a new method of treating sewage because it "simulates more closely than any other the basic phenomena responsible for the natural self-purification of sewage-polluted streams," according to its originators, Harry N. Jenks, sanitary engineer, and Max Levine, bacteriologist of the Iowa State College Engineering Experiment Station, where this method was evolved while conducting an investigation and research on the disposal of packing-house waste. In an article in the "U. S. Public Health Reports" describing the process, Messrs. Jenks and Levine say: "Systematic studies, both in the laboratory and in the field, have demonstrated the fact that, in practical operation, the stream-flow principle gives promise of furnishing an improved means of treating sewage and other organic waste, as viewed from the standpoints of efficiency and of decreased cost of construction and operation.

"When sewage enters a stream and is subjected to the treatment process as evidenced in the self-purification of streams, there succeeds an orderly sequence of stages of oxidation accomplished by the different groups of organisms adapted to the environment present throughout each of these stages. The rate of absorption of oxygen, as defined by the rate of reaeration of the stream, is proportional to the dissolved oxygen deficit, which, in turn, is a reflection of the oxygen demand exerted by the sewage from point to point along the course of flow. In contrast with this situation under natural conditions, the air supplied in the activated sludge process is ordinarily the same in amount from start to finish. The resultant tendency is toward an insufficient supply at the beginning and an excess near the end, or else a waste of air throughout the aeration period."

The authors state that they have determined from their investigations "that the typical 5-day deoxygenation curve quite well defines the general relative magnitude of the oxygen demand during successive periods of time," whether these be days or hours. "The current practice of supplying the same amount of air per unit volume of sewage from beginning to end of the aeration period is not in conformity with the fact expressed by Phelps 'the rate of biochemical oxidation of organic matter is proportional to the remaining concentration of unoxidized substance, measured in terms of oxidizability.' To take this condition into account requires the introduction of oxygen at the maximum rate at the beginning of the process, followed by a gradual reduction of the air supplied, corresponding to the decreasing oxygen demand exerted, until the completion of the aeration period is reached."

In consideration of these idea and facts, the authors proposed to reproduce the natural conditions of stream flow. In natural streams the decomposition of the sewage proceeds over a long course of flow, many miles in length, so that it

would be impracticable to reproduce in an artificial plant the time element in terms of distance traversed, and recirculation of the sewage over a controlled section was decided upon and a plant designed in accordance with the following basic assumption.

"1. The rate of biochemical oxygen satisfaction will proceed, in the presence of activated sludge, substantially in accord with the deoxygenation curve as derived for flowing streams, except that the biochemical oxygen demand will be fully exerted and satisfied within a foreshortened period of time.

"2. The effect of reaeration may be closely simulated by exposing the sewage flow in thin sheets to the atmosphere by recirculation over a reaeration surface comprising a controlled stream section distinctly separate from the zone of biologic activity wherein the oxygen so absorbed is utilized.

"3. The rates of recirculation of sewage over the reaeration surfaces at different points throughout the aeration period shall be adjusted to the actual biochemical oxygen demand correspondingly exerted."

This involves producing "essentially a biochemical oxidation zone contained in a tank or basin through which the main body of sewage progresses and a separate reaeration or oxygen absorbing zone embodied in a paved surface adjacent to or over the tank, over which an independent and concomitant recirculation of the organic wastes is maintained. The sewage is withdrawn from the oxidation zone, discharged onto the reaeration surface, and allowed to flow down the slope of this surface, thence returning into the oxidation zone within the aeration tank."

Streeter had apparently shown that $K = \frac{cV^n}{H^2}$,

in which K is the coefficient defining the rate of reaeration; c is a constant depending chiefly upon irregularities in different stream stretches, producing turbulence; V is the velocity of the stream in feet per second; H is the mean depth of flow in feet; and n is a constant defining the variation in reaeration rates in the same river stretch for different flow conditions. The minimizing effect of H may be practically eliminated by making the depth from 0.5 to 1 inch, thus presenting the maximum surface practicable for a given volume of sewage recirculated over the reaeration surface. The desirable velocity of flow over this surface to prevent deposition of sludge was assumed to lie between two and three feet per second, which corresponds closely with the range found by Streeter to be conducive of maximum values of K. "It has been determined that a slope of 1/2 inch per foot will give closely the desired velocity, even when transverse cleats are placed in the reaeration channel to induce riffing." "As regards n, in a channel of the type under consideration the hydraulic radius increases rapidly with increased depth, so that the velocity effect itself predominates, with a value of n close to unity; this is also true on account of the negligible effect of the depth H. The conditions of flow, therefore in a stream-flow plant are the counterpart of a natural stream progressing through a long series of riffles and pools, a condition known to be most favorable

to self-purification within a minimum distance, measured in time."

These ideas were embodied in a laboratory apparatus, and later in a field plant constructed at the Decker packing plant.

"Except for the aeration units, the structural features of a stream-flow plant conform in essential particulars to the general design followed in the case of the activated sludge process. That is, a complete installation might comprise preliminary settling tanks or screens, and final sludge settling tanks, together with appurtenances, in addition to the stream-flow aeration units themselves. As there is nothing in the aeration units to become clogged, whatever removal of suspended matter may be effected will be done to lessen the biochemical oxygen demand of the influent, or to recover such organic solids as may be utilized in the by-products department of the industrial plant producing the waste. Provision of pre-treatment by sedimentation thus becomes a matter of economics rather than one of necessity."

The recirculation of the organic wastes through the reaeration system, as the main body of sewage progresses through the oxidation tank, is secured by pumping. The problem here is a most unusual one, involving the discharge of relatively large volumes of sewage against an extremely low static head, amounting to perhaps not more than 4 to 6 inches. A screw pump might be used but is unduly expensive when designed especially for an extremely low head. Three special pumping mechanisms were devised for the Decker experimental field plant; one, a plow pump; the second, a propeller pump; and the third, a plunger box pump.

Tests were made in the laboratory plant on milk wastes, packing-house wastes, and sugar beet wastes. The authors state that the efficiency of the stream-flow principle of aeration has been shown to be consistently as good as that of diffused air when treating the industrial wastes mentioned. "It is believed that, in stream-flow aeration, the continual exposure of sewage to the atmosphere as it flows over the reaeration surfaces in thin films, more closely approaches the optimum condition for oxygen absorption than any design heretofore proposed."

"The division of the treatment process into two or more stages, developing and maintaining a distinctly separate activated sludge for each stage, was conceived as a means of favoring increased biologic efficiency on the basis of the considerations relating to biologic zoning of trickling filters." By stage treatment, two per cent milk waste was nitrified by stream-flow aeration units, while Levine has shown that even with an unlimited supply of diffused air it was impossible to produce nitrates in single-stage treatment by the activated sludge process.

"At least one important point that has heretofore not been adequately emphasized is the great advantage of removing as quickly as possible, from the aeration tanks, all excess sludge with its own high oxygen demanding characteristics gained by adsorption from the wastes being treated. This can be accomplished by intermediate settling between stages and so lessen the oxygen demand of succeeding stages." In the Decker plant, the plant influent remains for 1½ hours in aeration unit A, then

3½ hours in aeration unit B; then 45 minutes in a primary settling tank; then 7 hours in aeration unit C; then 45 minutes in a secondary settling tank; from which the final plant effluent is drawn. Some of the primary settling tank sludge is returned to the primary aeration unit A after re-aeration for one hour, and the excess is removed without allowing it to enter the secondary stage. Secondary sludge is returned to aeration unit C and the excess added to the excess from the primary settling tank, to be conveyed to the point of sludge disposal.

"Packing-house waste such as that found at the Decker plant can be treated by the stream-flow method through 12 hours' aeration, involving the recirculation of approximately 125 times the volume of sewage flow. Similar methods of computation applied to the case of domestic sewage containing some industrial wastes, resulting in a biochemical oxygen demand of 350 p. p. m., should be successfully treated through 6-hour stream-flow aeration of 50 times the volume of flow. For the latter case, assuming conservatively a lift of 4 inches and an over-all pumping efficiency of 25% water level to water level, the required energy for aeration should not exceed 12 horse power per m. g. d. treated."

In construction, "the reaeration surfaces may partly or wholly cover the aeration tanks or be laid as a pavement on natural ground along the edge of the structures. If the oxidation tanks are made of conventional depth, then the stream-flow aeration units will occupy very closely the same area as aeration tanks designed in the ordinary way. . . . Experiments indicate that the reaeration surfaces should be from 6 to 10 feet long, providing 3 to 5 seconds' exposure of the sewage film to the atmosphere at 2 feet per second velocity."

A Plant for Ready-Mixed Concrete

An unusually complete and up-to-date concrete mixing plant has recently been constructed for the Avril Tru-Batch Concrete Company at Cincinnati, Ohio, in planning which the president and general manager of the company, A. C. Avril, had as his object a plant that would be efficient to produce concrete to meet the most exacting specifications and inspection, and corresponding as close as possible to the mix made in the laboratory; this to be accomplished with ordinary laborers operating the plant and at a minimum labor cost.

The plant consists of four 18-foot diameter circular bins, each with a capacity of 196 tons; a 15-foot diameter cement bin with a capacity of 110 tons, or 587 barrels; a 200-ton, four-compartment batching bin; a bucket elevator; a belt conveyor; an enclosed elevator; and a two-yard mixer.

The four circular bins are used for storing the aggregate—sand, gravel and crushed stone. The use of these bins for storage instead of the stock pile method prevents segregation and, as a result, maintains the gradation of the aggregate, thus allowing the concrete to be designed on a fineness modulus basis. Mr. Avril divides the coarse aggregate into three sizes, and in each batch uses a portion of each size. By recombining these separate sizes, any gradation of coarse aggregate may be had. With this definite proportioning of aggre-

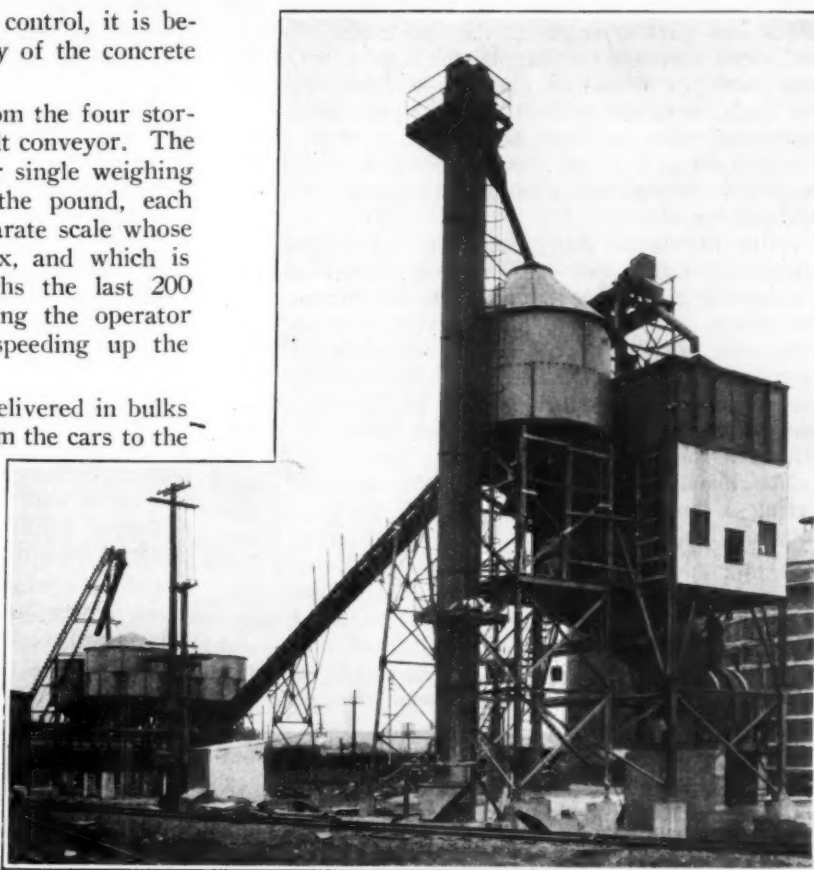
gate, combined with water-cement control, it is believed that the strength and quality of the concrete can be controlled very exactly.

The aggregates are conveyed from the four storage bins to the batching bin by a belt conveyor. The batching bin is equipped with four single weighing batchers, which are accurate to the pound, each batcher being equipped with a separate scale whose reading beam is enclosed in a box, and which is equipped with a dial which weighs the last 200 pounds of each batch, thus insuring the operator against having an overrun, and speeding up the operation.

The cement for the concrete is delivered in bulks in railroad cars. It is conveyed from the cars to the circular bin by means of an enclosed bucket elevator.

The cement bin has a steel cover and a side discharge bottom hopper. It is equipped with a weighing batcher having a separate scale whose reading beam is enclosed in a box and also carries an auxiliary dial. The batcher discharges onto a belt conveyor which conveys the cement to the batch hopper in the mixer.

The plant, which was designed and fabricated by the Blaw-Knox Co., is nearly automatic in its operation and requires no expert or skilled labor, and can produce as a maximum output 60 yards an hour with only four laborers and one foreman.



IN BACKGROUND, FOUR CIRCULAR AGGREGATE BINS. AT CENTER, ENCLOSED ELEVATOR TO CARRY CEMENT FROM CARS TO CIRCULAR CEMENT BIN. AT RIGHT, SQUARE BATCHING BIN, WEIGHING BATCHERS AND MIXER.

Asphaltic Limestone Surface on Old Gravel Road

Details of construction of surface of Alabama limestone on a gravel road consolidated by three years of wear of increasingly heavy traffic.

By J. H. Mayer*

A portion of the Bankhead highway west from Birmingham, Alabama, was built by the Alabama Highway Department as a Federal Aid project in 1925, conforming to the standard requirements as to alignment, grade, and drainage. The road was at that time surfaced with gravel, chiefly because considerable heavy grading was necessary, resulting in a number of heavy fills which would take some time to consolidate. As is often the case when new main roads are opened, the traffic on this project exceeded that anticipated, but until this year the road served its purpose, affording all-year traffic through a clay, shale country which, previous to the construction of this highway, had been almost impassable during winter months.

The state highway department has maintained the road since it was built and the compacting effect of traffic and the elements had consolidated the roadway so that it was in good condition to serve as a foundation for a new and better type of pavement.

It was therefore decided to utilize the old road bed for a foundation as far as possible, and to place upon it a surface consisting of a 4-inch black base and 1-inch asphalt wearing surface. The section built this year was 18.88 miles long, lying between Jasper and Carbon Hill. It was 18 feet wide with 4-foot earth shoulders.

Bids were received on sheet asphalt, asphaltic concrete, and asphaltic limestone. The contract was awarded in June, 1928, to the Morgan Hill Paving Co. of Birmingham, Ala., for Alabama asphaltic limestone.

In establishing the grades of the new surface, care was taken to adhere as closely as possible to the present wearing surface to minimize disturbance of the existing gravel. The engineer's grade stakes were set to the finished pavement surface on each side of the road; and to assure good line and grade and supply the necessary support at the edges, 6x6 wooden forms are used. These forms are dapped on opposite faces at the ends to allow for splicing.

*Chief engineer, Alabama Rock Asphalt, Inc.

This insured proper grade and alignment at the joints and gave strength at this point also. Holes are bored through the dapped ends to allow a $\frac{7}{8}$ -inch steel pin 18 inches long to be driven through the forms into the ground. These pins secure the forms together and also hold them in line. Care is exercised to have all forms set true to grade and line, with special attention to horizontal and vertical curves.

After the forms have been set, the subgrade is brought to the proper cross section and grade with a subgrading machine running on the forms. All low places are built up and curves super-elevated with new gravel. The entire subgrade is then thoroughly rolled with a 12-ton 3-wheel roller. The base is made with inverted curbs at the edges, and the extra excavation required for these is made after the rolling.

The black base is made with an inverted curb having a compressed thickness of 7 inches at the outside edge, reducing to 4 inches at one foot from the edge. Crushed blast furnace slag is used for coarse aggregate in the black base. A typical analysis of the base is as follows:

Bitumen 5%.
 Passing $1\frac{1}{2}$ inch and retained on $\frac{1}{2}$ inch sieve, 50%.
 Passing $\frac{1}{2}$ inch and retained on 10 mesh sieve, 18%.
 Passing 10 mesh sieve 27%.

The wearing surface is composed of Margerum asphaltic limestone produced by the Alabama Rock

Asphalt, Inc. This material has a native bitumen content of not less than 5%, and there is added sufficient asphalt of 85-100 penetration to bring the total bitumen to from $9\frac{1}{2}$ to $10\frac{1}{2}$ per cent. A typical analysis of the surface course as laid is as follows:

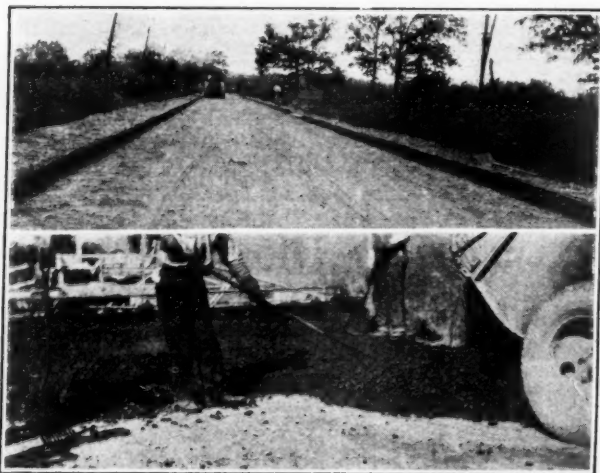
Bitumen 9.7%.
 Passing 200 mesh 12.4%.
 Passing 80 mesh 11.0%.
 Passing 40 mesh 20.7%.
 Passing 10 mesh 28.2%.
 Passing $\frac{1}{4}$ or 4 mesh 11.8%.
 Passing $\frac{1}{2}$ or 2 mesh 6.2%.

This surface material gives a high density with very low percentage of voids, producing a pavement of very high stability.

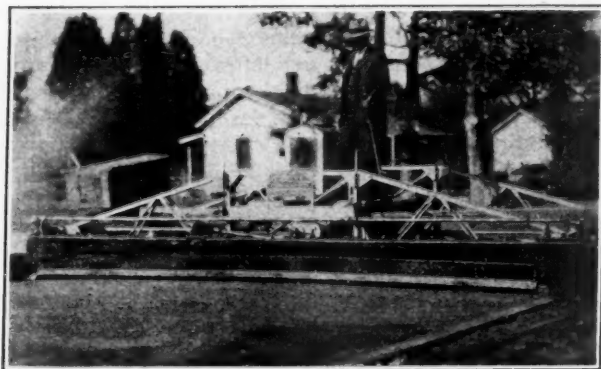
The contractors decided to work the job from both ends and one set-up was made at Hillard, about $2\frac{1}{2}$ miles west of the eastern end of the road, and a second set-up near Carbon Hill about the same distance east of the western end.

Paving operation was started in August from the Hillard plant at the eastern end of the project and progressed west to the proximity of the plant. Laying operations were then transferred to a point about 8 miles west of the plant, working east to Hillard. About October 1st the second plant near Carbon Hill went into operation working in the same way as at Hillard.

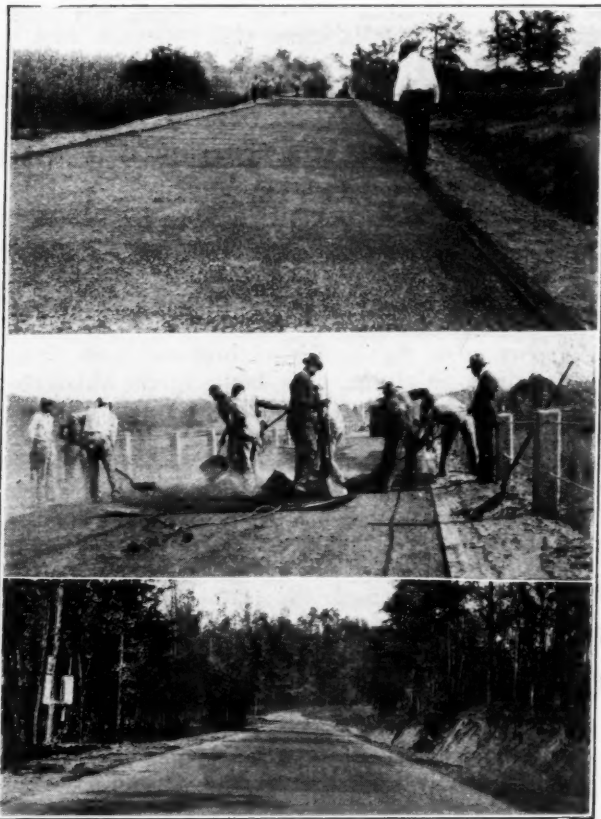
Two small Cummer plants are used at Hillard and the single large Cummer plant at Carbon Hill. The average daily base yardage produced from each of these plants has been 1,500. The general proce-



TOP—ADVANCE FORM SETTING, AND ROLLING OF SUBGRADE.
 BOTTOM—TRUCK DUMPING BLACK BASE MATERIAL DIRECTLY ON SUBGRADE.



BLACK BASE FINISHED WITH FINISHING MACHINE.



TOP—BLACK BASE AFTER ROLLING.
 MIDDLE—HAND SPREADING OF WEARING SURFACE.
 BOTTOM—COMPLETED WEARING SURFACE.

ture is to lay base for two days and top the third day. This gives an average production of 3,000 square yards of top per plant per day.

Three-yard White trucks with hydraulic dump bodies and two-yard Indiana trucks with gravity dumps are used for hauling the material. Both base and surface mix are dumped on approved dump boards and shoveled into place by hand. At the beginning of the job hand raking and finishing were used. On both base and wearing surface, initial rolling is done with 10-ton three-wheel rollers, with a subsequent rolling with 8-ton tandem rollers. The engineers go carefully over the black base with a ten-foot straight edge, and if it be found uneven it is brought to proper grade before the surface is laid. The finished asphaltic surface is also straight-edged and irregularities corrected.

About the first of November it was decided to

try machine finishing and a Lakewood finishing machine was placed on the eastern end of the project. Dump boards were dispensed with and the material is now being placed direct from trucks onto the subgrade, regulating chains on the rear dump gates of the trucks permitting the base material to be deposited satisfactorily on the subgrade ahead of the finishing machine, a small amount of hand work sufficing to spread properly for mechanical finishing. Surface material is dumped directly on the black base and spread with the finishing machine, which travels on the wooden forms. The adjustable screed is set at the required height for spreading and finishing the base and then adjusted for finishing the wearing surface. Straight-edge inspection behind the machine showed an improvement in initial smoothness over hand placed and raked material.

Georgia Highway Maintenance

Kind and type of equipment found most desirable for an earth road state and its most advantageous use and distribution. Automatic wheelers, tractors, graders, asphalt heaters, and their uses.

By J. F. Coleman*

Georgia, like many earth-road states, has had to invest heavily in machinery and earth-moving equipment, and despite the fact that full advantage was taken of the distribution of surplus war materials in securing needed equipment, her investment is very great indeed. And it has been necessary to study closely the kind and type of equipment most desirable and its most advantageous use and distribution, in order that the utmost economy could be employed in its purchase.

The state is separated into divisions of fifteen to twenty counties each. The county is the unit for maintenance purposes, and as the county mileage varies from fifteen to over a hundred miles, the maintenance requirements vary accordingly. In the system of distribution of equipment adopted, enough

one of which has a dump body; two 8-ft. graders, and two sets of 8-ft. three-blade drags. For larger sections this is sometimes supplemented by a 2-ton, 5-ton or 10-ton tractor, or a large truck with appropriate machines, or a one-man power grader; the choice depending largely on type of road and volume of traffic.

In addition to the equipment stationed at each county headquarters, each division has from one to three heavy outfits consisting of one 10-ton tractor, two 12-ft. road machines, one 3-ton truck and one 1-ton truck, which are assigned to several counties each and do the heavy ditching, machining and scarifying which the lighter outfit is incapable of handling. This outfit goes from one county to another as needed and is invaluable in saving the lighter



STRING OF AUTOMATIC WHEELERS TURNING ON 24-FOOT ROADWAY.
An illustration of the adaptability of an outfit of this kind.

is allocated to each county to take care of all routine work in that county. The average county mileage is 41 miles, and for a typical county of that mileage in a strictly earth-road section the maintenance equipment will consist of one 5-ton tractor; one 3-ton or 5-ton truck for dragging; two 1-ton trucks, at least

outfits from heavy straining work and in being able to accomplish far more in the way of ditching and grading than the smaller outfits.

AUTOMATIC WHEELERS

Some divisions have from three to five 1¼-yd. automatic loading and dumping wheelers for use either independently with a 10-ton tractor, or in

*Maintenance engineer, State Highway Board of Georgia.

connection with a heavy outfit; and such a unit can do rapid and economical work on short hauls. They are especially valuable in emergency work, as in filling large washouts; also in opening up new routes or detours where considerable earth work is required. An outfit of five wheelers and one 10-ton tractor can be operated if necessary by one tractor driver and two men to load and dump. Under favorable conditions the loading, hauling and dumping is a continuous operation, the outfit remaining in constant motion. A unit of this kind is very mobile—easily assembled and can be moved with rapidity from place to place. Very often they are sent out with only the tractor driver present, the loaders being picked up from the regular maintenance crew in the county being worked. A truck for hauling supplies can be operated by one of the loaders when moving from one job to another, and supplies can be loaded and brought out in the mornings by the regular crew; so that on ordinary jobs three men can be said to constitute a regular crew where plowing is found unnecessary. In heavy soils it is necessary to have a 5-ton or 10-ton tractor and plow for loosening the material for loading, or else use the loading tractor for plowing; but in lighter soils this is unnecessary. In very light, loose material one 10-ton tractor can easily load eight 1¼-yd. wheelers.

It is advantageous in building fills with automatic wheelers to work from a cut at each end of the fill, as this eliminates one complete turn on the fill; also, it allows each turn to be made on firmer ground and a longer radius; however, turns can easily be made without stopping on a 24-ft. roadway, and narrower if necessary.

These outfits offer many advantages over truck outfits, such as quicker loading, quicker dumping, fewer men to operate, ability to go in where trucks can not, much lower operating cost, smaller upkeep and less superintendence.

Up to certain hauling limits—depending on condition of footing—one 1¼-yd. wheeler may be depended on to do more work than one 1-ton truck.

The chief disadvantages of this outfit are in being confined to comparatively short hauls and dependent entirely on one piece of equipment, the tractor, for mobility.

The most important thing to watch is the mechanical condition of the tractor and wheelers—they must be watched closely, serviced regularly and not abused. If this is done, first class results can be expected.

Automatic wheelers are very often used in connection with the heavy divisional outfits, and, attached to such an outfit, complete a unit that is unequalled for road building purposes, as all the elements for building a road are present from clearing and grubbing to finishing the grade. The 1-inch steel cable used to connect rear grader directly to tractor can be used for pulling stumps and trees in clearing and grubbing. One of the graders has a scarifying attachment that can loosen small roots and grass in low fills and on low grade lines, and the blade can machine them aside. There is a plow for loosening hard earth and wheelers for loading and dumping. The graders, by leveling and smoothing the surface, can establish grades and pull the ditches; and the back slope attachment can further widen

and deepen the ditches, thus completing the entire job. The beauty of this is that, if necessary, it can be done with just three men; though in work of this extent it is economy to have additional labor and, as before stated, if much plowing is to be done, another tractor with additional crew is desirable.

Where the quantities are large and plowing is required, a good method is to have another unit of wheelers with another 10-ton tractor and plow, so that when this extra tractor is not busy at plowing, etc., it can be used in moving dirt, thus adding just 100 per cent to the output.

UNIFORMITY OF PRACTICE

The safety and convenience of present-day traffic demand uniformity in the most minute details of highway maintenance; the un-uniform, the unexpected, is a source of danger. When a road of a certain type is encountered, traffic forms its opinion of the road's condition in the first few miles it traverses and regulates its speed and attention accordingly, so any great deviation from the general condition is likely to prove dangerous. Maintenance instructions should take cognizance of this important fact and see that uniformity is secured wherever possible and deviations clearly marked.

It is desirable for the uniformity of methods and policy that instructions be issued to maintenance men collectively, assuring that all receive them alike. To this end, complete regulations should be published and copies sent to each patrolman, so that dependence for full and proper instructions should not depend on the irregular and incomplete method of issuance of circular letters, or the wholly inadequate word-of-mouth system. At least annual meetings should be held for the discussion of methods tried and results obtained since the previous meeting, and the further issuance of instructions be based on these findings.

There can be only one correct method of doing a certain thing, and any other method is an economical loss; so we urge the necessity of following a standard and uniform method in the prosecution of maintenance work in all its phases. Roads of the same types should be repaired, machined and marked in the same manner, the order of routine work should be uniform. Regular periods for attention to equipment should be appointed; all work should be scheduled as far as practicable, and if the schedule is broken into it should be re-scheduled. Every means of eliminating haphazard and slipshod methods should be adopted.

SHOULDER AND SLOPE PROTECTION

From a check up of expenditures it has been determined that a large percentage of maintenance funds each year is spent filling shoulder washes. In one instance it was ascertained that \$1,200 was spent filling shoulder and slope washes after one rain in 1¼ miles of fill, and the next month practically all of it again disappeared during one heavy rain. Such a lesson as this has made us realize the importance of shoulder and slope protection, and every effort is being made to get this protection by getting grass started on all permanent locations. Bermuda grass is found to be the best in this territory.

We feel that grassing is of primary importance and are stressing its cultivation immediately follow-



RESULT, IN OCTOBER, OF SOWING BERMUDA SEED
IN JUNE.

These shoulders are well matted over and will not be affected by winter rains. In foreground, an economical and effective method of treating crossings. The headwalls are made of discarded bridge decking and are serviceable for four or five years. Side drains may be treated in like manner.

ing construction as a part of the construction program; also we are using every means to get it started on old projects and locations where it was neglected.

We have found that in favorable soils one pound of Bermuda seed mixed with ten pounds of pulverized fertilizer as a sowing medium will cover 1,000 square feet of surface sufficiently well with grass during one season to protect it fairly well from washes the succeeding winter, if it is sown reasonably early. One method we use in sowing is to rake the surface heavily by hand, using a garden rake, sow the seed and cover by raking with the back of the rake. The seed should be gotten in deeply enough to avoid being washed out in ordinary rains. In heavy clays and pure sand, planting is more successful than sowing; if planted early and in rows twelve inches apart and twelve inches in drill, it will mat over in one season. Each planting should be a half-handful of live, vigorous grass with as much original soil as possible around its roots. In dry, hot weather it should be moistened if possible and covered immediately before it has a chance to dry out.

MACHINING

Proper machining is the most important factor in the serviceability and durability of an earth or gravel road. Primarily depending on machining, it can be a first-class, a fair, or a poor road. Too much stress cannot be laid on this important maintenance function, and careful and detailed instructions should be given governing proper methods to use.

It is necessary for a patrolman to study each part of a section to determine the time and methods best suited to its proper machining; and as the particular attention demanded by each individual mile cannot very well be given it, a close study will show the general plan that will give the best results as a whole. Often it is necessary to machine a part that is not yet ready in order to get to another part that is; but in such case the equipment should immediately be returned and the first part gone over a second time. If possible, equipment should be kept nearest the section of road that dries soonest, so that it can be

worked in the order in which it dries.

All roads subject to machining should be worked by the same general method. Machining should commence at one shoulder and the loose material be carried all the way across and feathered out on the opposite shoulder. Then, beginning at the opposite shoulder the next time, the road is gone over and the section repeated. This method will not only fill up small holes and depressions, but will better preserve the cross section and do away with the dangerous practice of leaving a ridge of loose material in the center of the road.

If it is desired to raise or lower the crown of the road, this method will have to be varied to suit the need.

A light mulch of loose material $\frac{3}{4}$ to 1 inch thick should be maintained on the surface of all types of machined roads. This is particularly necessary on gravel surfaces. This mulch should be kept evenly machined over the entire riding surface. It helps preserve the bonded surface by taking up the slippage and skidding effect of traffic and greatly resists the formation of ruts and pot holes.

Ridges of material along the edges of the surfacing should be avoided, as they cause longitudinal flow; also they impound water, softening the surfacing and base, causing ruts and mud holes to appear.

Gravel and similar surfaces are usually turned over for maintenance in first class shape, and it is far less of a job to construct them than to maintain them properly. Maintenance must begin promptly and proceed regularly and intelligently; holes and depressions must be brought up with first-class material as they appear, and all tendencies to get out of shape checked immediately.

The necessity for machining with 5-ton and 10-ton equipment decreases when an earth road is gravelled or sand-clayed, as lighter outfits can then secure enough footing to propel themselves under loads; also the surface will hold its shape much more satisfactorily after machining. It is found that frequent light machining with a one-man power grader or truck with drags will give better results and is more economical than occasional machining with a heavier outfit. There is a patented blade attachment that can be fastened transversely to the bottom of 3-ton and 5-ton truck frames about midway between front and rear wheels which, when set at the desired pitch, angle and elevation, is held in the same relative position by springs, which makes a satisfactory light, one-man machining outfit. The road that is habitually machined with a light outfit is likely to develop waviness from a tendency of the light equipment to ride the bumps and the shorter wheel base to follow



HEAVY OUTFIT—10-TON TRACTOR, TWO 12-FOOT GRADERS, ONE 3-TON TRUCK, ONE 1-TON TRUCK AND STRING OF AUTOMATIC WHEELERS.
A cable runs directly from tractor to wheelers, taking the pulling load off the graders. A plow, back-sloper, small tools, oil and gas are carried in the trucks.

its contours, and for that reason it should have an occasional working with a long-base, heavy grader.

The lighter outfits offer the advantages of economy in fuel, parts, personnel and upkeep; while they give greater speed, allowing more mileage to be covered and permitting more frequent machining. This method of machining is very important on gravel and similar type roads which depend so much on the covering of a light mulch of fine material on their surface for satisfactory service. This mulch should be kept evenly spread over the whole wearing surface and to do this means very frequent working. It has been found that frequent light working of this light mulch will greatly aid in the prevention and elimination of corrugations which become so troublesome at times.

It is a mistake to think, as sometimes happens, that good results can be obtained from machining only after rains, for, to keep a gravelled surface in good condition under even moderately heavy traffic, machining must be daily in any weather except when too wet. Good results can be obtained even in protracted dry spells; however, dry-weather machining should be with light equipment only, and the once-used method of pushing out and pulling in the loose top material should never be resorted to.

The final test of whether a gravel road has been properly maintained is whether or not it requires scarifying. A properly constructed, properly maintained gravel road should *never* require scarifying, and when it does, maintenance has fallen down somewhere.

It is important to bear in mind that waves and long depressions caused by subsidence or shrinkage of the foundation cannot be remedied by machining—additional surface material is the only answer to that, and any attempt to cure it by heavy machining will result only in a seriously cut-down surfacing in one spot and thickening in another.

SPECIAL ASPHALT EQUIPMENT

The demand for immediate paving of extensive mileage has developed various types of light surface treatments on gravel and kindred bases, and their maintenance forms a goodly share of the yearly



APPLYING LIGHT SEAL COAT.

Man is backing as tractor is hauled slowly forward. Stag trucks applying stone follow immediately behind. Pump attached as described in article.

program. It follows from their character that failures will be greater than in the higher types of pavements; still, they will not be extensive enough to demand the use of the larger, construction type of equipment. As practically all of these lighter type pavements have been of an asphaltic character, it seemed that a compromise between the usual 50 or 100-gallon heater with hand-pouring pot and the large pressure distributor should be found, and a fairly satisfactory answer was found by using a 300-gallon oil burning heater on wheels, equipped with barrel hoist and warming chamber, with the following changes: the hand pressure pump that was clamped inside the melting chamber was found to be too clumsy and wasteful of time, so a hole was drilled in the side of the heater at the left rear and about two inches above the bottom pan, and the intake pipe of the pump was connected up directly with the heating chamber of the kettle, then the pump was welded on to the side of the heater, after the attaching clamps had been taken off. The gear ratio of the pump was changed to give added pressure, and the plain nozzle in the hose was replaced by a nozzle to give a spiral motion to the asphalt. With an outfit of this kind it was found that 1,000 gallons of asphalt could be passed through the pump in one day, making it possible to meet almost any ordinary maintenance demand. In seal work, the kettle can be moved slowly forward by a truck at a gait just sufficient to allow application of the desired amount of asphalt, and the cover stone can be applied from one or two trucks backing up behind the kettle, making the operation continuous.

Attaching the pump on the outside at the bottom permits of introducing fresh asphalt to the already melted material while still in operation without the necessity of removing the pump entirely from the kettle at each emptying and waiting for the new material to melt before resuming operations, as was necessary before.

The plain nozzle that came with the pump threw a thin fan-like stream that made it necessary to go over a small area immediately the second time, or give the nozzle a waving motion back and forth in order to get sufficient material in one application. The first method has too many drawbacks for comment and the second resulted in alternately fat and lean places that soon developed a washboard-like surface, very uncomfortable to traffic. But with the added volume and pressure of the gear change and the different flow-direction given by the new nozzle, all this was done away with and a steady flow was obtained that permitted an even and sufficient distribution.

Toll Roads in England

Under the above title we published in the November issue some information about some proposed toll roads in England to be built by a syndicate. Further information given by the Department of Commerce is to the effect that travel will probably be allowed on these roads at 60 miles an hour; that they will be flanked by an avenue of 140,000 trees, and that colored reflectors will be installed on either side for the guidance of night drivers. It is expected that work will begin next summer on the first of these toll highways.

Recent Legal Decisions

HIGHWAY CONSTRUCTION CONTRACT MADE WITH VOLUNTARY ASSOCIATION

The Missouri Supreme Court holds, *State v. Cox*, 1 S. W. (2d) 787, that a contract for the construction of a segment of state highway, made with individuals calling themselves the "Missouri State Highway Board" was not forbidden by law, immoral or against public policy, so as to be invalid; and if such a voluntary association could enter into such a valid contract, it could take a valid bond for the faithful performance of the contract on the part of the contractor, in which the surety could, independent of any statute, obligate himself to laborers and materialmen for the payment, upon the principal's default, for all material and labor furnished under the contract.

OBSTRUCTING WATERWAY CROSSING HIGHWAY AT RIGHT ANGLES.

Kentucky Stat. §§4338, 4343, forbidding the obstruction of ditches along the public road, are for the protection of the road and not for the protection of the adjoining property owners in the case of a waterway which crosses the highway at right angles, and the obstruction of such a waterway is not within these statutes. In an owner's action against construction contractors for damage by flooding caused by such obstruction, an instruction that the obstruction was in violation of the statute law of the state should not be given. *White Const. Co. v. Brooks*, Kentucky Court of Appeals, 1 S. W. (2d) 1076.

DIFFERENCE BETWEEN ALTERATION AND VACATION OF HIGHWAY

There is a material difference between making alterations in a public highway and discontinuing or vacating it. In the one case the road is kept up leading to the principal points, although it may be by alteration upon different ground from that on which it was first located. In the other it is abolished altogether, the authorities are exempted from keeping it in repair and it may be stopped up entirely. A statute providing for a discontinuance of an established road does not apply to the case of an alteration (*Thompson v. Crabb*, 6 J. J. Marsh (Ky. 222)), and a statute authorizing the opening of new roads and to make necessary changes in old roads does not govern a proceeding to vacate a road.—*Hill v. W. Clintock*, Arkansas Supreme Court, 1 S. W. (2d) 564.

CONSTRUCTION OF ROAD GRAVELING CONTRACTOR'S BOND—RIGHTS OF SUBCONTRACTORS

A contract bond undertook that a contractor for the graveling of a state highway should pay all wages of laborers employed by the contractor or his agent, and all claims for materials furnished. The contractor made a subcontract for the work. The subcontractor made still another subcontract, he furnishing the cars the second subcontractor agreeing to "spot" them. In an action by the second subcontractor against the first, the original contractor and the surety, on the stoppage of the work by the

contractor, a finding of the trial court that the first subcontractor was the contractor's agent was sustained. The plaintiff was held not entitled to recover for the use of a tractor to spot the cars, this being covered by the price per yard for gravel loaded. The surety company's undertaking did not require it to pay any damage that a subcontractor or materialman might sustain by reason of the contractor failing to take all the material he had contracted to take. Its obligation was for "all claims for materials furnished." The moving of oversized gravel by the plaintiff was not within the surety's obligation, since this was not for wages to laborers of the contractor or its agent, nor for materials furnished, as specified in the bond. *Kampeska Materials Co. v. Bone*, South Dakota Supreme Court, 219 N. W. 244.

DISPOSAL OF SURFACE WATER

The Minnesota Supreme Court holds, *Felepe v. Town of America*, 219 N. W. 158, that while surface water has to be taken care of in the construction and improvement of public highways, its disposal will necessarily have to be adapted to existing public drainage systems so as to permit them to function substantially as established. Towns in the improvement and maintenance of public highways are without authority substantially to change or interfere with the operation of duly established drainage systems. The evidence was held to sustain findings that the defendants wrongfully, by means of a road ditch, dam and enlarged culverts, discharged more surface water than originally came into a public drainage system as established, thereby flooding plaintiff's land and damaging his crop.

LOCATION OF STATE HIGHWAYS

The Kansas Supreme Court holds, *City of Mankato v. Board of County Commrs. of Jewell County*, 266 Pac. 96, that a city which is a county seat has no capacity to maintain an action against the state highway commission and the board of county commissioners with respect to the location of highways through the county which form a part of the state highway system.

SUFFICIENCY OF COMPLAINT IN ACTION FOR BALANCE DUE ON STATE ROAD CONSTRUCTION CONTRACT

The Indiana Appellate Court holds, *State v. Wright*, 161 N. E. 839, that, in an action against the state on a contract for the construction of a state road, the allegation that the proper state officers had admitted that there was a balance due and issued a certificate for that amount, to be in full settlement, which was refused, was sufficient, in itself, to render the complaint good as against a demurrer for want of sufficient facts. But where there was no averment that the wages for labor and the rental price for machine power, tools and equipment were agreed upon in writing before commencement of the action, the complaint was held insufficient to warrant a recovery for these force account items.

**PLANS AND SPECIFICATIONS SUBMITTED FOR
BIDDING UNDER NEW YORK HIGHWAY
LAW MUST COMPLY WITH STATUTE**

New York Highway Law, section 262-a, requires submission to and approval by the board of supervisors of plans, specifications and estimate of expense in relation to a particular type of bridge expressly proposed to be built. Plans, specifications and estimates for a steel bridge have no relation to a concrete bridge, even when the board is aware of its necessary length, breadth and location, and their submission would not comply with the statute. Bidders could not comply with the statutory requirement that he should be deemed the lowest responsible bidder who specifically states the lowest gross sum, including all the items specified in the estimate. *Brown v. Ward*, New York Court of Appeals, 246 N. Y. 400, 159 N. E. 184.

VARIATION FROM STATUTORY PUBLIC WORKS BOND

Oklahoma Comp. St. 1921, §7486, requires the officers of a municipal subdivision, when contracts are made for public buildings or other public improvements included in the scope of the statute, to require the contractor to execute a bond to the state of Oklahoma. The bond required by this section of the statute must be conditioned to pay all indebtedness which the contractor may incur for labor and material. When such a bond is executed the surety is liable as per the conditions thereof. Where officers of a municipality fail to require a bond conditioned as by the said section, but do require a bond conditioned that the contractor shall faithfully perform the contract on his part according to the terms, covenants and conditions thereof, and the public improvement is completed by the contractor to the satisfaction of the municipality, there is no breach in the conditions of such bond, and the Oklahoma Supreme Court holds, *American Sash & Door Co. v. McGregor*, 264 Pac. 692, that the surety is not liable to a materialman for material furnished the contractor in completing the work, since the terms and conditions of the bond cannot be extended by implication.

**PRESUMPTION OF ACCEPTANCE OF WORK BY CITY
IN ACTION BETWEEN CONTRACTORS**

The Washington Supreme Court holds, *Kellogg v. Nelson*, 264 Pac. 15, that, since every public officer is presumed to do his duty, there was a presumption, in an action by a sub-contractor against a contractor for construction work and his surety for work performed for a city, that the city commissioner of light and water had authority to accept the work and to make his acceptance a matter of record by filing it in the city clerk's office; and in the absence of all proof on the subject, this presumption was held sufficient to sustain judgment for the sub-contractor.

**MUNICIPALITY'S POWER TO CONTRACT FOR GARBAGE
DISPOSAL**

The fact that city garbage may have some value as food for hogs does not limit the power of municipalities in providing by ordinance for its disposal and transportation only by authorized persons or deprive private persons of property without due process of law. *Ex parte Santo* (Cal. App.) 264 Pac. 281.

**"LABOR" IN CONTRACTOR'S BOND HELD TO INCLUDE
WORK OF TEAM**

The Kansas City Court of Appeals holds, *State v. Detroit Fidelity & Surety Co.*, 300 S. W. 833, that a road contractor's bond conditioned on the contractor's payment of all lawful claims for materials used and labor performed includes as "labor" the work done by a man and a team on the road construction and does not apply only to the work of the team.

**NO DUTY TO WARN PEDESTRIAN OF OBVIOUS DEFECT
IN STREET CLOSED DURING CONSTRUCTION**

Where a city in Massachusetts had the right, under the state statutes, to construct a sewer and to close the street wholly or partially to travel during the work of construction, provided sufficient means were taken to caution the public against entering thereon, and the condition of the street and sidewalk, where the soil from the trench was piled so as to leave only a two foot strip for walking, and the rain water had worn an irregular channel about eight inches deep across the sidewalk, was known to a pedestrian, so that no notice could have given her greater information than she possessed from her own observation and knowledge, the Massachusetts Supreme Court held, *O'Neil v. City of Boston*, 160 N. E. 311, that the city owed no duty to a pedestrian, suing for injuries sustained by slipping into the gully, to warn her against entering the street and using the sidewalk as a public way.

**CONTRIBUTORY NEGLIGENCE OF PEDESTRIAN
STUMBLING ON PROJECTION IN SIDE-
WALK AS A DEFENSE**

A pedestrian stumbled on striking with her heel a fanlike projection on the sidewalk where the cement had melted and run. The projection jutted out about 16 inches and was irregular and slanting. It had existed for two or three years, and had been noticed at other times by the pedestrian, who lived in the neighborhood. An action for injury was tried upon the theory of nuisance. The New York Court of Appeals holds, *McFarlane v. City of Niagara Falls*, 247 N. Y. 340, 160 N. E. 391, that the condition was a nuisance growing out of negligence rather than from wrongdoing; and therefore contributory negligence of the injured pedestrian, if proved, would avail as a defense. The court said, in part: "The danger may be so apparent that a traveler ought to have seen it, though he professes he did not. A presumption of safety will not serve as an excuse for blind indifference to consequences. One must use the streets as others use them. The wayfarer, who has the sense of sight, is not to close his eyes or travel as one blind (citations omitted)"

**VALIDITY OF PROCEEDINGS TO RECURB AND RE-
GUTTER STREET**

The Kansas Supreme Court holds, *Bentley v. Gunn*, 266 Pac. 28, that proceedings by a city of the second class to "repave, repair, and otherwise improve (and to recurb and regutter where necessary)," a city street, are not rendered subject to an injunction at the suit of taxpayers owning property along the street by the fact that neither the resolution nor the ordinance specifies the place or places where the recurbing and reguttering are to be done.

NEWS OF THE SOCIETIES

Jan. 14-18—AMERICAN ROAD BUILDERS' ASSOCIATION. Annual Convention and Road Show at Cleveland, O. C. M. Upham, Washington, D. C.

Jan. 16-18—AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual Meeting at New York. Geo. T. Seabury, Sec'y., 33 W. 39th St., N. Y.

Feb. 12-14—AMERICAN CONCRETE INSTITUTE. Annual Convention at Detroit, Mich. Harvey Whipple, Sec'y., 2970 W. Grand Blvd., Detroit, Mich.

Feb. 13-15—ASSOCIATION OF STATE HIGHWAY OFFICIALS OF THE NORTH ATLANTIC STATES. Fifth Annual Convention. A. Lee Grover, Sec'y, Trenton, N. J.

Feb. 18-22—ASSOCIATED GENERAL CONTRACTORS OF AMERICA, INC. Annual Meeting at Chicago, Ill. D. H. Sawyer, Sec'y., Washington, D. C.

Feb. 26-March 1—SOUTHWEST ROAD SHOW AND SCHOOL. Fourth Session at Wichita, Kans. F. G. Wieland, manager.

May 13-15—NATIONAL HIGHWAY TRAFFIC ASSOCIATION. Annual Convention. Stevens Hotel, Chicago. Secretary, Elmer Thompson.

June 24-28—AMERICAN WATER WORKS ASSN. Annual Convention at Toronto, Ont. Beekman C. Little, Sec'y., 170 Broadway, N. Y.

AMERICAN ROAD BUILDERS' ASSOCIATION

More than 30,000 people will be present at the 26th Annual Convention and Exposition of the American Road Builders' Association, which will be held in Cleveland, January 14-18, 1929. This attendance will comprise highway engineers, officials and contractors from all states in the Union, as well as representatives and delegates from 28 foreign countries.

The program of the convention will consist of the reports of the various committees appointed from the seven divisions of the association.

On City Officials' Day, Captain H. C. Whitehurst, assistant to the Engineer-Commissioner of Washington, D. C., will preside. The program will comprise the reports of the committee on administration, organization and finance, the committee on design and construction of city pavements and streets, the committee on maintenance of city streets, and the committee on traffic control. In addition to this, a special committee appointed for the purpose of studying subgrades and pavement bases in cities will make a progress report. C. A. Hogentogler of the Bureau of Public Roads is chairman of this committee.

City governments are undergoing a continuous change, but during the past few years there has been an indication of standardization of city government. This subject will be covered in a special paper presented by W. R. Hopkins, city manager of Cleveland.

On Pan American Day the program will be in charge of the Pan American division. Thomas H. MacDonald, chief of the Bureau of Public Roads, and Octavio Dubois, president of the National Highway Commission of Mexico, will act as co-chairmen of the session. Papers will be presented by

delegates from the Pan American countries, setting forth the interesting facts of the road activities in their respective countries. A complete description of the Central Highway of Cuba will be presented, also a description of the Federal highway construction in Mexico; a resume of the road activities in Canada and the financing of the system of roads in Chile. In addition to these, there will be several other interesting papers by the visiting delegates.

Special sessions which will include subjects of paramount importance in the highway construction field at the present time will be presented by the prominent contractors of the country.

On County Highway Officials' Day the program will consist of the reports of committees made up entirely of county highway officials and covering county surveys and planning, county highway construction, rural county highway maintenance, urban county highway maintenance, county highway legislation, county administration, county construction and maintenance equipment, and county highway finance. There will also be a special paper on the procedure for making an economic survey and plan for county highway development.

A special committee on grade crossings, headed by E. W. James of the Bureau of Public Roads, will present its report. This report is of unusual interest to all engineers and officials, as well as representatives of railroads, for it will include the outstanding practices in grade crossing elimination and many other details necessary in the development of this item.

Recently there was held a joint meeting composed of committees of the American Association of State Highway Officials and the American Road Builders' Association for the purpose of determining problems which could be considered cooperatively by the two associations. It was decided at that meeting to carry on cooperative work on national highway legislation and standardization of equipment; and also that it should be the policy for an officer of the American Association of State Highway Officials to present at the annual convention of the American Road Builders' Association a resume of the activities and achievements of the American Association of State Highway Officials during the past year. The two above-mentioned committees will meet on Monday, January 13th, to consider their subjects in detail.

Special headquarters will be established at the convention and exposition for the state highway officials, county highway officials, city officials, highway contractors, engineers and officials, manufacturers and Pan American divisions, and the delegates are invited to make use of the headquarters thus placed at their disposal.

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There will be attendants in charge at all times.

The annual Road Builders' Banquet will be held in the Hollenden Hotel on Wednesday evening. Special features have been obtained to make this banquet highly interesting and an outstanding event.

The Road Exposition will be the largest of its kind ever held. Over 500 carloads of the latest improved road-building equipment and materials, occupying a space of almost 8 acres, will be on display for inspection and comparison. Much new development has been accomplished in the way of labor-saving equipment during the past year. Many manufacturers are bringing out for the first time new machines designed for the purpose of constructing better roads at lower cost. Much new maintenance equipment has also been developed during the past season and this will all be on display at the Road Builders' Exposition.

The railroad companies have again granted reduced railroad fares to the convention. This reduction is based on the certificate plan and enables the delegates to obtain their return railroad tickets at one-half the price.

There will be sufficient hotel accommodations to care for all delegates.

SHORT COURSES FOR SEWAGE PLANT OPERATORS

Rutgers University announces three short courses for Sewage Plant Operators to be held January 14-26, 1929, under the direction of the College of Engineering in co-operation with the New Jersey Sewage Works Association and the New Jersey State Board of Health.

The purpose of the Rutgers Short Courses for Sewage Plant Operators is primarily to offer intensive training in the fundamentals of Sewage Disposal and Sewage Plant Operation. It is an opportunity through which plant operators may better qualify themselves to solve their individual problems, to increase their general knowledge of sewage disposal and its relation to the public health and thereby enable them to discuss more intelligently, with the officers of their municipality the needs and necessary changes in their plants. Furthermore, it will afford opportunity for those men wishing to become operators, to qualify themselves to meet the requirements of the New Jersey State Board of Health for such positions.

The Short Courses will extend over a period of two weeks, beginning with registration on Monday, January 14, and ending Friday afternoon, January 25. Classes will be scheduled daily from 9 to 12 in the morning and from 1:30 to 4:30 in the afternoon and ending at noon on Saturday.

Course I: Professor Lendall, Lectures and recitations—16 hours. The elements of design and construction of different types of treatment plants—details of operation and maintenance. Laboratory exercises—23 hours; Prof. van der Meulen: Lectures and demonstrations by the instructor and actual determination and tests by the student.

The work will cover the principles of chemistry as applied to sewage treatment, determination of solids, digestion of solids, hydrogen ion concentration, biochemical oxygen demand, sterilization and other phase of operation with which the operator is concerned.

Course II: Professor Lendall, Lectures and recitations—6 hours. Comparison of the design of existing plants with operation data. This course is planned to show how details of design may be changed to improve operation and efficiency. Laboratory—40 hours, Dr. Rudolfs: A continuation of Course I with more detailed study; the adjustment of the reaction of a tank by addition of lime, odors and their control, biochemical oxygen demand and Bacteriology. Some time will be given to water purification.

Course III—Sewage Plant Testing: Professor Lendall and Dr. Rudolfs, Lectures—6 hours, laboratory—35 hours. Methods for making extended tests on sewage plants. Sampling and preservation of samples. Analyses and interpretation. Measurement of stream flow and stream pollution.

The many problems of plant operation and design will be treated in informal discussions for which definite periods will be scheduled. These discussions will be led by men of experience and who are thoroughly acquainted with plant conditions in New Jersey and nearby states.

There are no educational requirements for admission to any of the courses. Admission to Courses II and III will be based entirely on training and experience. A nominal fee of five (\$5) dollars is charged for admission to any course. A receipt from the Treasurer of the University must be obtained for admission to classes.

Registration will begin at 9:00 A. M. Monday, January 14, in the Engineering Building, and continue throughout the day. All persons are requested to register promptly, before noon, if possible, as the regular program of the day will begin at 1:30 in the afternoon. Full instructions regarding the details of the courses will be supplied at the time of registration.

MISSOURI CONFERENCE OF WATER PURIFICATION

The fourth and most successful Missouri Conference on Water Purification concluded its meetings at Hannibal, Missouri, November 17th. Interest in the program was evidenced by unusually good attendance of the seventy-five members and guests present, as well as lively discussions following the presentation of all papers.

Several changes were made in the constitution of the Conference. The name was changed to Missouri Water and Sewerage Conference in order to indicate the present scope of interest including municipal sewerage as well as water systems. Provision was also made to accomplish affiliation of the Conference with the Federation of Sewage Works Associations.

The time and place of next year's meeting will be determined by the incoming executive committee. Following are the officers elected for the ensuing year: Chairman, C. E. Heflin, water commissioner, Cameron, Mo.; vice-chairman, S. J. Duncan, superintendent of waterworks, Moberly, Mo.; secretary-treasurer, H. D. Peters, assistant engineer, State Board of Health of Missouri; executive committee, W. V. Wier, assistant manager, St. Louis County Water Company, University City, Mo.; E. E. Wolfe, city chemist, Hannibal, Mo.; W. P. Britain, superintendent of waterworks, West Plains, Mo.; J. N. Wells, superintendent, Joplin Water Works Co., Joplin, Mo.

MUNICIPAL ENGINEERS' CLUB OF AKRON

There has recently been formed in Akron, O., an organization known as the Municipal Engineers' Club and Library Association, which includes in its membership a large percentage of all engineers in the employ of the city of Akron. W. R. La Due is secretary and treasurer.

ASPHALT PAVING CONFERENCE

The Seventh Annual Asphalt Paving Conference was held at New Orleans, La., Dec. 3 to 7, under the auspices of the Asphalt Association and the Association of Asphalt Paving Technologists. About 500 delegates representing nearly all parts of the country, and also a number of foreign countries, attended the sessions and enjoyed the entertainment features.

L. M. Law, of New Orleans, president of the Association of Asphalt Paving Technologists, welcomed the delegates to the city and Colonel John P. Sullivan formally greeted the visitors in behalf of Governor Long. Acting Mayor W. T. Hall presented the visitors with the keys to the city. Commissioner of Public Property John Klorer of New Orleans, told of the progress made by this city in street paving.

O. K. Allen, chairman of the Louisiana highway commission could not be present because of illness. He was represented by James M. Fourmy, engineer for the commission, who traced the history of the recently ratified paved roads amendment in this state.

T. Warren Allen, chief of the division of management of the United States bureau of public roads, M. H. Ulman, assistant engineer of materials for the Pennsylvania highway department, and Charles Draney, superintendent of the municipal asphalt plant at Denver, Colo., led discussions of technical problems involving asphalt paving.

The wives of the delegates were taken on a tour of the Vieux Carre and the harbor Tuesday morning and afternoon.

Tuesday night Colonel Harry H. Blee, chief of the airport section, office of aeronautics of the United States department of commerce, discussed the role being played by the airplane in American business and commerce, and told of the rapid growth of commercial aviation.



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A SEWER PIPE JOINT COMPOUND

No caulking is necessary with JOINTITE. Alternate joints may be poured on the bank. No skilled help required. Excludes ground water, thus paying for itself.

7 CATALOGS

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Catalog Nos. 30 and 24—Automatic Siphons for Large Municipal Disposal Plants, etc.

Catalog No. 31—Imhoff Tanks.

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PACIFIC FLUSH-TANK CO.

4241 Ravenswood Avenue, Chicago

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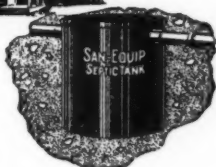
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ALL SIZES—200 GALS. TO 4,000 GALS.

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Cheaper
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4" tile
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CHEMICAL TOILET CORP.

Syracuse, N. Y.

HOME SEWAGE DISPOSAL

By W. A. HARDENBERGH

Associate Editor of Public Works

The only book covering thoroughly and from the engineering viewpoint the disposal of sewage for unsewered areas.

82 illustrations, 282 pages

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He said there were 1000 airports now under construction in the United States, and 1000 more are contemplated. At present, he asserted, there are 18,000 miles of scheduled airways, of which 7500 miles are lighted.

Colonel Blee was followed by A. H. Blanchard of Toledo, O., who spoke on paving airfield runways, and by F. H. Eno, of Ohio State University and Chris P. Jensen, of Fresno, Cal.

Members of the resolutions committee were elected at the business session as follows: C. B. Filbert, Cincinnati; J. B. Hittell, Chicago; A. K. Vickery, Denver; C. N. Conner, Washington, D. C.; A. H. Blanchard, Toledo; B. L. Boye, New York; R. Keith Compton, Richmond, Va.; F. A. Hogan, Toronto; H. C. Ehrenfels, New Orleans; H. W. Skidmore, Chicago; H. F. Harris, Trenton, N. J.; J. T. Bullen, Shreveport; W. B. Catchings, Raleigh, N. C.; R. S. Dulin, Portland, Ore., and R. E. Gray, Keyser, W. Va.

W. J. Emmons, of the University of Michigan and research worker for the Michigan state highway laboratory, opened the second day session of the conference with an address upon upkeep and maintenance of highways. He spoke in place of V. R. Burton, who was unable to be present.

Mr. Emmons stated that a five-inch base pavement was inadequate. He declared that a reinforced seven-inch base pavement would cost less than 1 cent per square yard per year for upkeep. B. P. McWhorter, member of the Georgia state highways body spoke in place of W. R. Neel. Other speakers included V. L. Ostrander, R. M. Smith, J. D. Waldrop, T. C. McEwen and Major J. M. Fourmy.

Tuesday afternoon was spent enjoying a boat trip on the river, a visit being paid to Caernarvon, where the levee was cut in the spring of 1927. Wednesday afternoon, the delegates attended the races. Wednesday evening session was devoted to the proceedings of the Asphalt Paving Technologists. Thursday sessions were of technical nature and included a number of papers on methods and trends of practices, and on the practical application of various tests.

PERSONALS

A. W. Koehler has been appointed Secretary of the National Conference on Street and Highway Safety. Mr. Koehler has served recently as secretary of the Safety Council of the Rochester, N. Y., Chamber of Commerce.

Col. I. C. Moller, Universal Crane Co., Cleveland, has been named an honorary vice president of the National Highway Traffic Association.

John J. Albertson, for 35 years County Engineer of Camden County, New Jersey, died recently. Mr. Albertson was responsible for the development and construction of the fine system of highways which Camden County possesses.

CIVIL SERVICE

Draftsmen.—Applications for Mechanical Draftsman, \$1,800 a year; Assistant Mechanical Draftsman, \$1,620 a year; Junior Mechanical Draftsman, \$1,440 a year, must be on file with the Civil Service Commission at Washington, D. C., not later than January 23. The examinations are to fill vacancies in the Departmental Service, Washington, D. C., and in positions requiring similar qualifications throughout the United States. The entrance salaries for these positions in the Departmental Service, Washington, D. C., are as indicated above. Higher-salaried positions are filled through promotion. For appointment outside of Washington, D. C., the salaries will be approximately the same. Competitors will not be required to report for examination at any place; but will be rated on their education, experience, and fitness, and specimens of drawing and lettering to be filed by the applicant.

Junior Engineer.—Applications for junior engineer must be on file with the Civil Service Commission at Washington, D. C., not later than January 22. The examination is to fill vacancies in various branches of the service throughout the United States. The entrance salary for positions in Washington, D. C., is \$2,000 a year. For appointment outside of Washington, D. C., the salary will be approximately the same. Higher-salaried positions are filled through promotion. The optional subjects are (1) aeronautical engineering, (2) agricultural engineering, (3) chemical engineering, (4) civil engineering, (5) electrical engineering, (6) mechanical engineering, (7) mining engineering, (8) naval architecture and marine engineering, and (9) structural steel and concrete engineering. The duties are to perform routine testing, inspection of engineering material, drawing up plans for minor projects, preparing specifications for engineering material or apparatus, performing field work, making computations, preparing maps, assisting in conduct of experimental research tests, compiling reports, and handling technical correspondence. Competitors will be rated on general physics, mathematics, general engineering, and the optional subject chosen from those named above. Senior students will be admitted to the examination.

Junior Chemist.—Applications for junior chemist must be on file with the Civil Service Commission at Washington, D. C., not later than February 5. The examination is to fill vacancies in the Federal classified service throughout the United States, including the Departmental Service at Washington, D. C. The entrance salary in the District of Columbia is \$2,000 a year. For appointment outside of Washington, D. C., the salary will be approximately

the same. The optional subjects are advanced inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry. Competitors will be rated on general chemistry and elementary physics, and the optional subject selected.

Information.—Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

TRADE PUBLICATIONS

"Standard" Surface Application Asphalts

The Standard Oil Company of New Jersey has brought out a good deal of interesting and exceedingly valuable information on this subject in a recent 24-page booklet issued by them.

Wet Walls and Efflorescence.—American Face Brick Ass'n., Chicago, Ill. Illustrated, 28 pages. Presents as briefly as possible the outstanding facts about the occurrence of efflorescence on masonry walls, and how to avoid it. Based on two investigations conducted for the association by the Bureau of Standards.

Air Compressors—Centrifugal Air Compressors for Sewage Disposal. The General Electric Co., Schenectady, N. Y. A 4-page folder outlining the results of recent exhaustive studies of the design requirements for centrifugal air compressors, with especial reference to use in activated sludge plants.

Centrifugal Pumps.—Dayton-Dowd Co., Quincy, Ill. Bulletin 267, Illustrated, 40 pages. This bulletin contains detailed information on Type CS pumps for medium and high service; Type CSLH for low heads; and large capacity pumps for water works, filtration plants, drainage and irrigation works. The information covers specifications and construction details, ratings and dimensions.

Barrett, Haentjens & Co., Hazelton, Pa., have issued a bulletin dealing with automatic pumping systems. The subject is treated in a complete though simple manner, the aim of the company being to issue a publication which is technically correct and at the same time one that can be understood by the average mechanic, electrician or even a non-technical reader. It shows how the centrifugal pump can be started and stopped by a float switch, push button, pressure regulator, or time switch. It explains the way in which the pump is primed, and describes the several devices used to protect the pump and electrical equipment against damage due to loss of prime, suction air leaks, a broken discharge pipe, and many other adverse operating conditions.

NEW CATALOGS

Core Drills. Dobbins Core Drill Co., Inc., Long Island City, N. Y., a 48-page illustrated catalog describing core drills and discussing drilling.

Rock Crushers. Bulletin No. 100, 4 pages, illustrated, describing New Holland Rock Crushers. Type K, jaw crusher.

Pipe Driving Tools. Sweeney & Gray Co., Long Island City, N. Y., an 8-page illustrated catalog describing hand power pipe driving machinery.

Open Roads at Low Cost. Four-page illustrated folder on snow removal. Published by Trackson Co., Milwaukee, Wis.

Loadmaster Swing Crane. Frederick H. Poor, Inc., New York. A circular describing the AMD type swing crane.

Aerol Burner Co., West New York, N. J. Bulletin No. 72, 16 pages, illustrated, describing winter construction tools for heating, thawing, melting ice, and snow removal.

Vertical Air Compressors. Worthington Pump and Machinery Corp., N. Y. Bulletin L-620-B1, with questions and answers regarding vertical feather-valve compressors.

The Wagner Electric Corporation, St. Louis, Mo., has just issued a new bulletin describing Wagner large RA single phase repulsion-induction motors.

James B. Clow and Sons, Chicago, Ill. An illustrated booklet in colors, containing a description and illustrative data regarding R. U. V. ultra violet ray water sterilizers.

Presstite Engineering Co., St. Louis, Mo. An illustrated folder describing methods of making tight sewer joints by the use of Presstite preformed asphaltic joints. Full instructions are given.

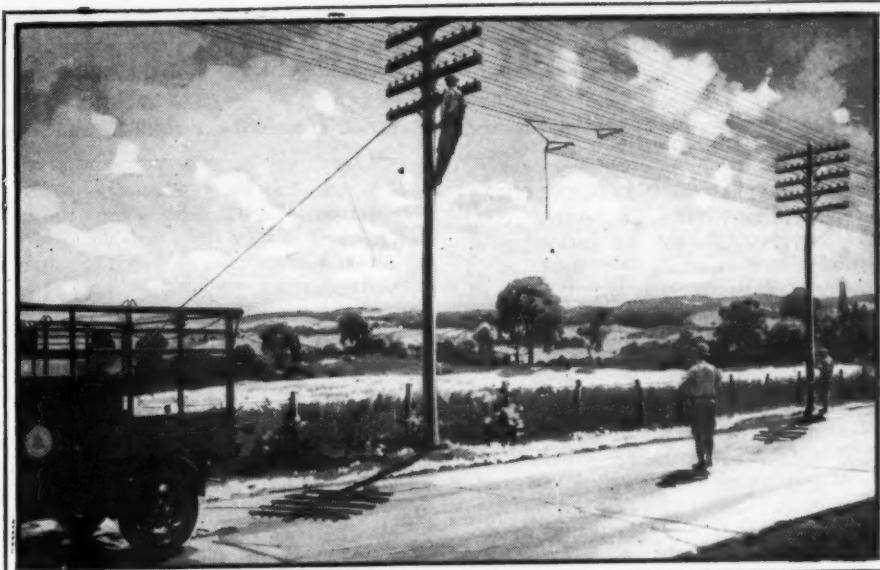
Chausse Oil Burner Co., Elkhart, Ind. A 4-page illustrated folder, circular No. 14, describing Chausse oil burning concrete mixer heaters and kerosene torches.

Geo. D. Whitcomb Co., Rochelle, Ill. A 20-page bulletin (2824) of information on narrow gauge gasoline locomotives ranging from 10 to 30 tons.

International Cement Corp., New York. A four-page illustrated folder describing the use of Incor high early strength portland cement in reducing traffic obstruction due to pavement repairs.

Central Tube Co., Pittsburgh, Pa. 48-page catalog describing and giving specifications of Central tubes. Also describes methods of construction. Tables show outside diameter, thickness, weight per foot and test pressure for pipes and tubes.

Marion Steam Shovel Co., Marion O. Bulletin No. 337, 16 pages, illustrated, describing the Marion Type 450, 1¼-yard, gas-electric shovel. Bulletin



The U.S.A. is only a few minutes wide

*An Advertisement of the
American Telephone and Telegraph Company*



IN THE gold rush year of '49 a stagecoach succeeded in crossing the continent in about three months. Two decades later, for the first time, an unbroken stretch of railroad lay from New York Harbor to San Francisco Bay, and America was seven days wide. Today, by telephone, that entire width is only a matter of minutes. And these few minutes represent a round trip, taken in the ease of office or home.

The Bell System is ever busy reducing the width of America and the distance between cities. For example, during 1929 it will add to its lines nearly 2,000,000 of the new permalloy loading coils for correcting and maintaining the speeding voice currents.

Seven thousand miles of new inter-city cable, \$40,000,000 worth, will be added to the System to protect against storms and other slowing up influences.

"THE TELEPHONE BOOKS ARE THE DIRECTORY OF THE NATION"

In the last five years 350 major improvements, as well as thousands of others whose aggregate importance mounts high, have been made in telephone central office equipment.

Improved operating practices have eliminated the necessity of your "hanging up" and being called back in 95 per cent of toll and long distance calls, adding new speed and ease to out of town calling. You hold the wire and the operator does the rest.

Since New Year's Day, 1927, the average time for completing all out of town calls has been cut 35 per cent and at the same time the per cent of error has been further materially reduced.

There is no standing still in the Bell System. Better and better telephone service at the lowest cost is the goal. Present improvements constantly going into effect are but the foundation for the future's greater service.

No. 336, 16 pages, illustrated, describing the Marion Type 480, 2-yard, steam shovel. Bulletin No. 335, 16 pages, illustrated, Marion Type 480, electrically driven shovel with Ward-Leonard control. Bulletin No. 334, 16 pages, illustrated, describing the Type 480 with electric rheostat control. All these are suited for use as draglines and clamshells.

Water Softeners. Crystalite is the subject of illustrated bulletin 183 is-

sued by the International Filter Company, Chicago, Ill. This attractive 16-page technical booklet discusses the chemistry of zeolite water softening, the early history and development of zeolites, crystalite, the advantages of upflow softening (illustrated with curves), and the adaptability of Crystalite to upflow softening. International Crystalite water softener installations are shown, and important uses of Crystalite softened water are listed.

New Appliances and Equipment

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

Barber-Greene Excavator

The Barber-Greene Co., Aurora, Ill., has just brought out an excavator of entirely new type. The machine is briefly: A sturdy chassis, mounted on crawlers, with four Barber-Greene vertical booms (similar to the boom on the B-G ditcher) going ahead of the chassis. It will interest every type of contractor, whether his work is general excavation, road grading, road cutting, road filling, stripping, air port, athletic field, golf course or race track construction.

The Barber-Greene excavator in excavating the material prepares it for other uses. It has a constant milling action identical to the action of the B-G

cluding the following: Country road, city streets, athletic field construction, race grading, tennis court grading, gravel pit stripping, cellar excavation, and sub-division court grading.

New Trackson Bulldozer

The Trackson Co., Milwaukee, Wisc., has announced a new Trackson Bulldozer mounted on the Model DH Trackson McCormick-Deering unit. This Bulldozer is equipped with the mechanical hoist which has been proved in the Trackson shovel, loader, and crane.

The similarity of the hoisting assemblies and also of the frames of the Trackson bulldozer, shovel, loader, and crane permits the ready interchangeability of these front-end attachments. This is a decided advantage in that it permits the owner to use the same power unit with all Trackson auxiliary equipment and for many kinds of work, thus reducing his investment costs. The Bulldozer is designed and mounted on the power unit in such a way that the thrust or push is taken on the crawler frame, eliminating undue strains on the tractor.

The Bulldozer has an 84-inch blade, and is claimed to be an efficient, economical unit for leveling city dumps, back-filling sewer trenches, ditches, etc., and many other similar operations.

The Blaw-Knox Agitator Truck Body

The Blaw-Knox Company of Pittsburgh, Pa., among the leaders in the development and manufacture of central mixing plants, for ready mixed concrete have added to their line of manufacture the agitator truck body, invented by the Graham Brothers, contractors and ready mixed concrete dealers of Richmond, Virginia.

The principle of the agitator truck body is simple. The concrete is proportioned and properly mixed by a

trained operator under required supervision and inspection at a central mixing plant. The concrete is then transported to the job in the agitator truck body, designed simply to keep the concrete constantly in agitation. The method of agitation is such as to absolutely prevent any segregation for



BLAW-KNOX AGITATOR TRUCK BODY FOR HAULING CONCRETE

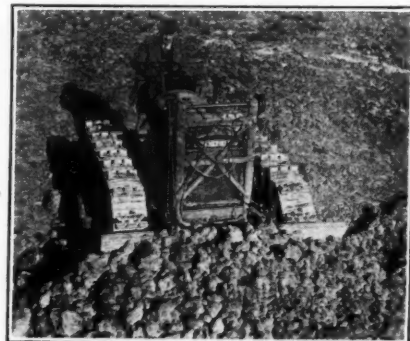
ditcher, thus sending the material off the end of the discharge conveyor in the form of ground up material, suitable for all kinds of filling.

Principal features of the machine are that it is built to stand the toughest sort of digging, and is designed with the primary thought of having it do the most accurate grading. The machine can cut 1 inch off the surface, or 7 feet. It makes a cut 8 feet 5 inches wide. The booms are in two units of two bucket lines. Each unit is controlled independently of the other.

The capacity of the machine is estimated at from one to three yards per minute. The machine is a constantly digging device. If it is discharging into wagons or trucks, the operator's job is throwing out the clutch at the end of a load and letting it back at the start of the next.

Dials show the depth of the cut and the relation of the two boom units to each other. The operator controls the digging angle and depth as the whole boom mechanism is raised and lowered by power.

During the experimental stages, the machine has worked on actual jobs in-



TRACKSON "BULLDOZER"

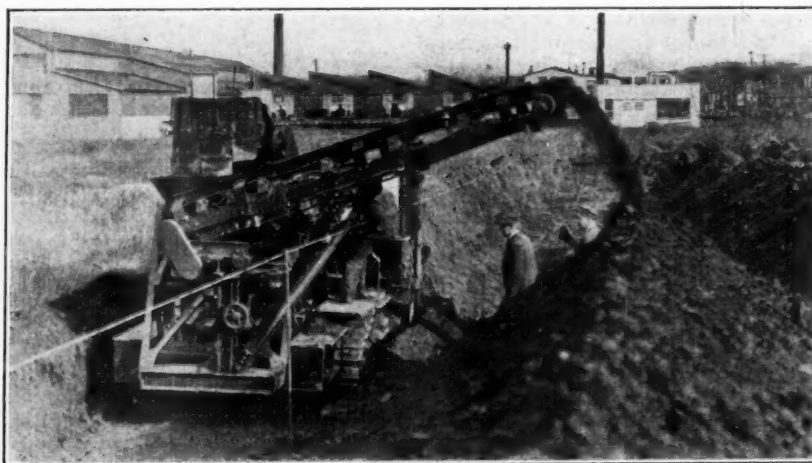
any mix, whether dry or wet. The agitating mechanism not only stirs in the circular cross section of the body, but keeps the concrete in constant circulation along the length of the body, thus insuring complete agitation.

The use of ten agitator bodies for a period of fourteen months at one of the most efficiently operated ready mixed plants in the United States has demonstrated that there is absolutely no segregation and that the concrete is more workable.

Complete manufacturing arrangements have been worked out, and the agitator truck bodies are now in production at the Blaw-Knox plant.

Le Blond-Schacht Body for Hauling Concrete

The Le Blond-Schacht Truck Co., Cincinnati, O., in collaboration with the Avril Tru-Batch Concrete Co., has



NEW TYPE BARBER-GREENE EXCAVATOR

brought out a new type of body for hauling wet concrete.

The capacity of the body is 2-yards when loaded to about 2-3 from the top. It is necessary to have the remaining space open to permit the concrete to be shaken up as the body revolves instead of moving as one solid mass if the body were loaded to the top.

The body can correctly be termed a "rotating cylinder" driven by means of a chain from a worm speed reducing unit through a specially designed ball bearing equipped transmission power take-off. At a vehicle speed of 25 miles per hour, the body revolves at the rate of $5\frac{1}{2}$ revolutions per minute. The speed can be varied to meet different requirements. The body rotates on special self aligning SKF roller bearings.

The body is filled and emptied by means of a water tight door operated by a gear and ratchet mechanism with a hand crank.

The Schacht chassis is of $2\frac{1}{2}$ tons capacity and is powered by a 6-cylinder Waukesha $3\frac{3}{4}\times 4\frac{1}{2}$ engine. It has a wheelbase of 126 inches and is equipped with 34×7 pneumatic heavy duty tires, duals rear, mounted on Budd wheels.

Continental Industrial Engines

Continental Motors Corporation, Detroit, Mich., has put out a complete new line of four-cylinder, $6\frac{1}{2}$ and $7\frac{1}{2}$ -inch stroke industrial engines of the slow speed type, designed especially for continuous and dependable heavy duty. The new models, eight in number, will be known as H21 to H28, inclusive.

In the design have been incorporated such engineering refinements as removable cylinder sleeves, overhead valves large crankshafts with five main bearings, dry sump oiling system, built-in governor, and longer and better proportioned pistons, all of which increase motor life and permit many more working hours at minimum expense.

The engine is of the four-cylinder, vertical, valve-in-head type. Cylinder bores in the eight engine sizes are $5\frac{1}{4}$, $5\frac{3}{4}$, 6, $6\frac{1}{4}$, $6\frac{1}{2}$ and $6\frac{3}{4}$ inches. Piston stroke in the four smaller sizes is $6\frac{1}{2}$ inches, and in the larger, $7\frac{1}{2}$ inches. Horsepower ranges from 39 in the smallest engines of the series to 125 in the

largest. Recommended governed speed is 1,000 r.p.m.

The removable sleeve cylinders are made of hard nickel iron. Cylinder heads are also of nickel iron, cast in pairs. The nickel iron pistons have three compression rings 3-16 inch wide, and one oil control ring $\frac{1}{4}$ inch wide, all four above the wrist pin, which floats in the piston and is held end-wise by snap rings.

The crankcase is of gray iron, cast integrally with the cylinder water jacket. The flywheel housing is a separate unit, bolted to the crankcase. The flywheel is of semi-steel, machined to take a twin-disc, single plate clutch. Exhaust and intake manifolds are cast separate, with outlet turned up at center and threaded for 3-inch standard pipe. The water pump is of the gear-driven, centrifugal type, with water outlets over exhaust valves and ports. The fan has 24-inch diameter blades, with triple V-belt drive. Lubrication is by the dry sump system, with the oil reservoir high and accessible on the cam-shaft side, capacity being three gallons.

The oil pump is of the two-stage, gear-driven type, giving pressure feed to all bearings at a normal pressure of 40 pounds. The oil filter and sediment basin form part of the main reservoir. Relief and regulating valve is on the end of the cam-shaft, ac-

cessible through the gear case cover.

Ignition is by high tension magneto equipment including magneto switch, cables, cable-holder and set of $\frac{3}{8}$ -18 standard spark plugs. The governor is of the gear-driven centrifugal type, located directly under the carburetor. The carburetor is of the vertical, $1\frac{3}{4}$ std., SAE flange, balanced type, located on the left side of the motor, opposite the cam-shaft. The air-cleaner is of the filter type, with oil-wetted element.

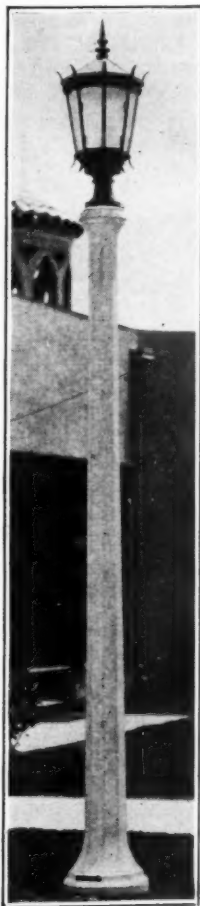
The motor is provided with three-point support, the front trunnion being cast integrally with the gear case cover.

Hollowspun Granite Lighting Standards

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., manufacture Westinghouse Hollowspun street lighting standards or posts of reinforced concrete. These are manufactured by a simple and unique process. The concrete is placed in steel molds in which the reinforcing elements or "cages" are assembled. These molds are then rotated at a high speed. This produces a dense, compact mass resembling stone in appearance and which for durability, toughness and strength is unexcelled.

The reinforcing structure consists of vertical steel bars and spiral wrappings. The diameters of these elements have been carefully calculated for each type of post, and their position in the molds is accurately maintained throughout the process of manufacture. In computing the strength of reinforcing elements, such factors as stresses due to handling during erection and other stresses, including that which might be caused by the impact of vehicles, are considered.

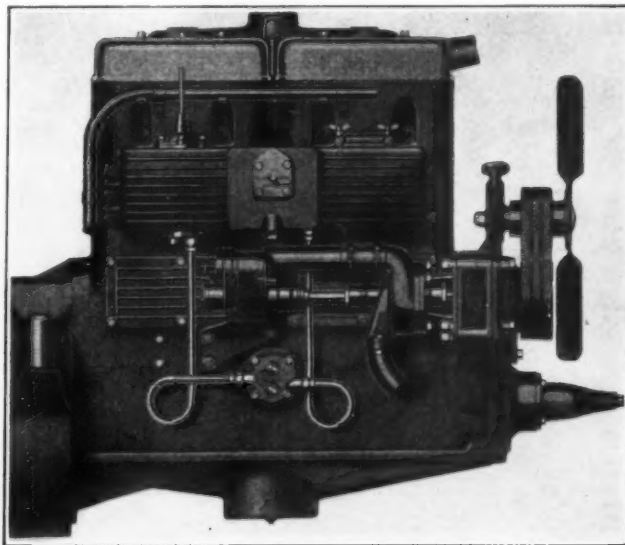
In Hollowspun posts the foundation is an integral part of the post, hence the building of foundations is unnecessary. All that is necessary is to dig a hole and set the post therein. This allows the setting of posts in any kind of weather and facilitates their erection.



WESTINGHOUSE
"HOLLOWSPUN"
LIGHTING
STANDARDS



LE BLOND-SCHACHT CONCRETE-TRUCK



"H" SERIES, CONTINENTAL ENGINE

From a maintenance standpoint Hollowspun posts are extremely economical. There being no metallic parts exposed to the weather there is nothing to rust, hence painting and other maintenance charges are eliminated.

The comparative lightness of Hollowspun posts is attained without sacrificing strength, and reduces freight charges to a minimum.

The centrifugal method of post manufacture produces a post of slender appearance which has the same or even greater tensile strength than a larger post made by any other method.

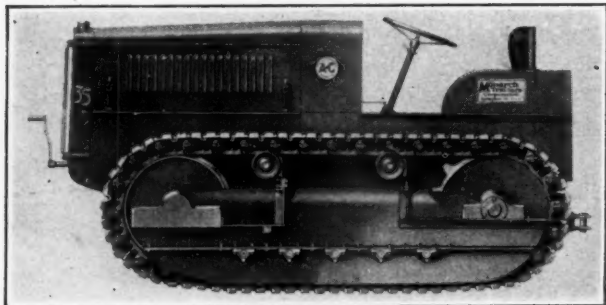
The aggregate used in making Hollowspun posts imparts an attractive appearance and thus eliminates the need of elaborate designs or scroll work. The black and white aggregate closely resembles cut granite in appearance. When desired an aggregate of red Wisconsin granite may be used.

The New "American" Sump Pumps

The American Well Works, Aurora, Ill., has just announced a new and improved line of sump pumps with many advantages. The "American" type M. D. sump pump differs from other motor driven pumps in that it employs a hollow shaft motor in place of the old solid shaft type. This construction makes possible a simple compact pump, and eliminates flexible couplings and thrust bearings. The pump shaft extends up through the motor shaft, hence both motor and pump use the same thrust bearing which is mounted in the upper end of the motor making adjustments very easy.

The elimination of high motor supports is made possible as the pump supporting pipe is bolted through to a cast iron plate that in turn bolts to the motor. Regardless of distortion in the pit cover, the alignment of the pump and motor is not affected.

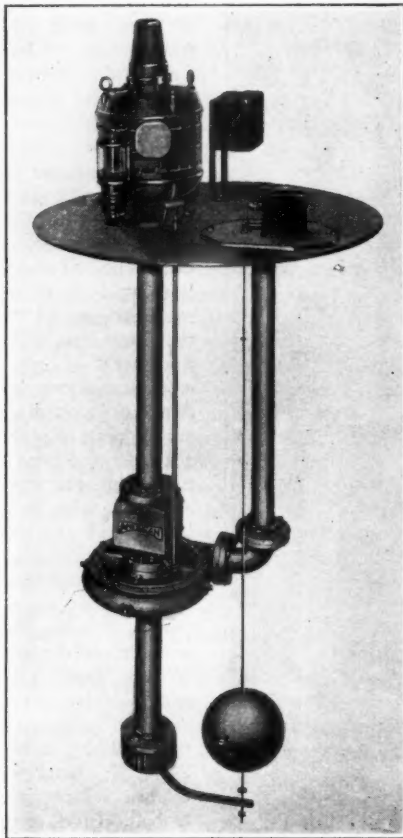
The pump shaft bearings consists of removable bushings. The pit plate is made of plate steel and is furnished either round or square. Pumps may be had for all standard settings up to 17 feet in either single or duplex units. All units are furnished complete with float control switch, oiling device and motor.



MONARCH "35" TRACTOR

New Allis-Chalmers Monarch Tractor

The Allis-Chalmers Manufacturing Company of Milwaukee, Wisconsin, announces a new track-type tractor for production and sales at their Spring-



AMERICAN SUMP PUMP

field, Illinois, plant early in 1929. This new model will be known as the Allis-Chalmers Monarch "35" and will be shown first at the Cleveland Good Roads Show.

This new Allis-Chalmers Monarch offers a maximum of 36 drawbar horsepower, three speeds forward and one reverse, 1.84, 2.75, 4.00 and 2.12 respectively. The engine is of a standard Allis-Chalmers type, designed and used exclusively for tractor work, and has four cylinders

with removable sleeves set in the block, $4\frac{3}{4}$ " bore $6\frac{1}{2}$ " stroke. Motor speed under full load is 930 R.P.M., and is under governor control. Length over all, including starting crank, is 10 feet 4 inches; height to top of radiator 5 feet $1\frac{1}{2}$ inches. A full pressure lubricating system and an oil PurOlator add considerably to its economical operation.

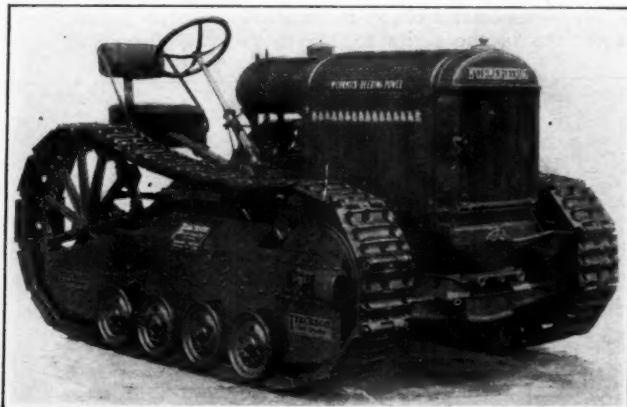
The track is of extra length, as in the larger models, the "50" and "75", providing maximum traction ability and an even distribution of weight. Features pertaining to the ease and facility of operation and the operator's comfort are incorporated in this machine. Steering is accomplished with a steering wheel and through steering clutches enabling the tractor to virtually turn in its own length. The Allis-Chalmers Monarch "35" is conservatively rated in accordance with the policy of the Allis-Chalmers Manufacturing Company in always maintaining an adequate reserve for peak loads. In general design, construction, and appearance, it is similar to the Allis-Chalmers Monarch "50" and "75" Tractors.

Model LH Trackson Full Crawler

The Trackson Co., Milwaukee, Wisc., has just brought out the Model LH Trackson Full-Crawler, which will be shown for the first time at the Road Show.

This new model of the Trackson is designed for mounting on the 10-20 McCormick-Deering Industrial Tractor, as is also the Model DH Trackson, which was introduced last year. The Model LH is a lighter and speedier crawler than the DH.

Mounted on the International power plant, the Model LH Trackson provides a 3-ton crawler tractor which has tremendous power and which retains the standard traveling speeds of the McCormick-Deering wheel tractor. The Trackson Full-Crawler gives the unit a sure footing and positive traction for work in the most difficult conditions, such as soft, loose or slippery ground where wheels could not travel. The crawler also increases the flexibility of



LH TRACKSON FULL CRAWLER

the unit by enabling it to turn in its own length, pivoting on the inside track.

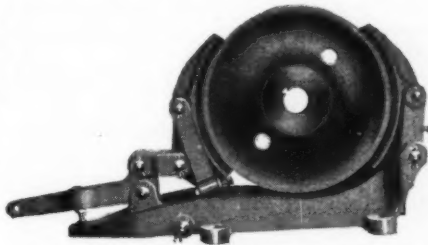
The LH has a heavier frame and greater strength than previous models. New features include a new type bushed track shoes, inserted manganese driving teeth on the rear sprockets, new style truck wheel bearing construction, and greater wearing surfaces on the truck wheel and track. The LH also has increased ground gripping ability. The need for adaptability to auxiliary equipment, such as motor patrols, hoists, loaders, shovels, bulldozers, cranes, snow plows etc., has been kept in mind. The Trackson is fitted with a special heavy electric steel front bolster casting which is firmly attached to the tractor with heat treated bolts. This casting is provided with two 1-inch tapped holes, making it possible and easy to attach front-end equipment rigidly by means of 1-inch cap screws.

National Street Sweeper

The National Sweeper Sales Co., San Francisco, Calif., handle the National street sweeper, which is manufactured by the Reliance Trailer & Truck Co., San Francisco. The machine employs as a power unit the McCormick-Deering tractor. The weight of the complete machine is about $3\frac{1}{2}$ tons; it sweeps 9 feet, and the dump bin capacity is 2 yards. The machine is claimed to operate on any type of sweepable pavement at a speed of from 2 to 12 miles per hour, according to the sweepable condition of the gutter and pavement. It is also claimed to remove every particle of street refuse and to wipe up all oil, grease and wet spots. Controls for the several units are all located within easy reach of the operator. The speed of the brushes automatically picks up with the forward speed of machine. The machine uses a mechanical principle that eliminates conveyors, suction and blower fans, and other similar machinery. A

disinfectant spray can be used in the gutter and on the brushes.

The operation of the machine is as follows: The gutter brush revolving in the gutter sweeps the refuse out to the path to be swept by the pick-up brush which picks up the refuse and throws it into the load bin. The forward movement of the machine, together with the rapid revolutions of the pick-up brush causes a suction which removes the finest dust from the pavement. This fine dust is blown by the pick-up brush



ELECTRIC CONTROLLER BRAKE

revolutions into the dust collector where the air escapes and the dust remains and falls into the load bin.

When the machine is loaded the operator can dump, and close bin from seat.

New Brake for Industrial Equipment

The Electric Controller & Mfg. Co., Cleveland, O., has announced a new brake arranged for lever operation. This mechanically-operated, Type WB Brake, is of the shoe type and is intended for the bridge drives of electric traveling cranes, lift bridges, electric hoists and other applications requiring foot-operated or hand-lever operated brakes. It is a modification of the EC&M Type WB electrically-operated brake; practically all wearing parts of the new mechanically-operated brake are interchangeable with parts of the electrically-operated brake.

The tendency toward the use of anti-friction bearings on cranes and other machinery has resulted in an increased amount of work to be performed by the brake. A crane equipped with anti-friction bearings will drift along with practically undiminished speed when the controller is shut off, with the result that the brake must stop the crane unaided by bearing friction. This has necessitated improved brake design with increased wearing qualities of friction linings. The type WB brake is equipped with unusually thick molded asbestos brake shoes requiring renewal only after very long periods of service.

Automatic Machinery for Water Works Plants

The American Machine & Foundry Co., Brooklyn, N. Y., manufactures automatic weighing machinery which is especially suited to use in water treatment plants. Their use eliminates all uncertainty as to the proper dosage of water. They are made in gravity and power feed types.

The three desirable features in a weighing machine have been built into

the gravity feed weighing machine. It is sturdy, well constructed and requires a minimum of floor space; it has but five working parts and is accurate without loss of speed. To insure a discharge of material at any interval of time it is also equipped with an automatic time tripping device.

This scale will efficiently handle such materials as alum sulphate, soda ash, salt, salicylate of soda, caustic soda (solid, ground, flake), chloride of lime, sulphate of iron, copper sulphate, etc., and any other chemicals of similar characteristics. For those chemicals which do not flow freely this scale can be equipped with an agitator within the intake hopper of the machine.

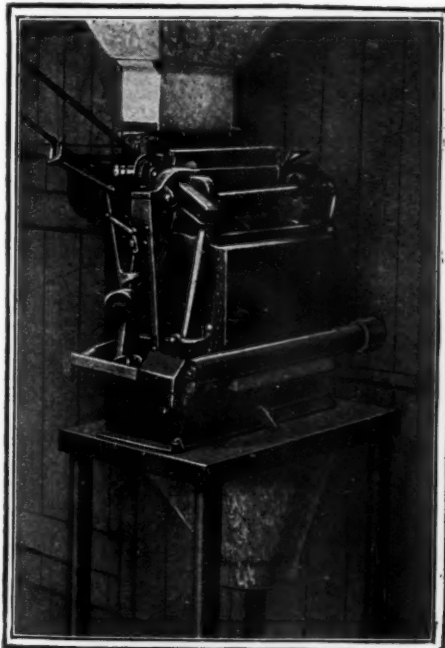
Similar in certain respects is the power feed weighing machine, which can handle the same list of chemicals as the other machine, but is built only with a power feed.

The materials may come in size from 200 mesh up to $3\frac{1}{4}$ -inch lumps and can be weighed readily in all intervening sizes.

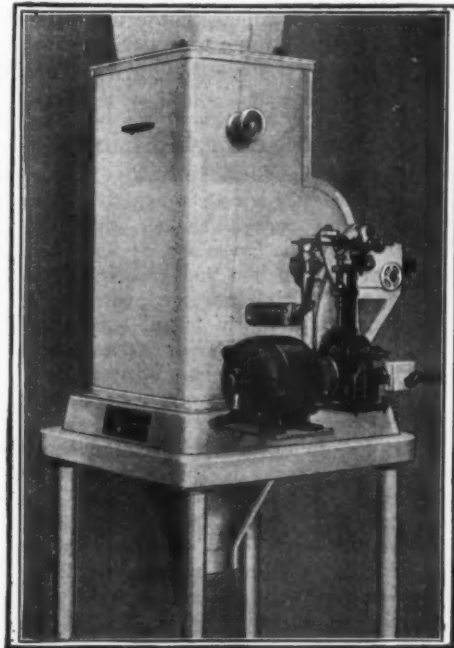
The principal features of this machine are the poise lever, the sliding poise weight for quick adjustments from one weight to another, the valve interlock, whereby no material can pass through the machine unweighed, and the automatic time tripping device which makes it possible to discharge any weight at any interval of time.

"Trenchmarine" Portable Centrifugal Pump

The Trench & Marine Pump Co., New York, manufactures the "Trenchmarine" portable centrifugal pumping units. These are made in capacities up to 8400 gallons per hour under a head of 20 feet. They are direct connected, the power unit being an air-cooled gasoline engine, thus eliminating danger of damage in cold weather. They are de-



POWER FEED WEIGHING MACHINE
Capacity 25 to 100 pounds per discharge

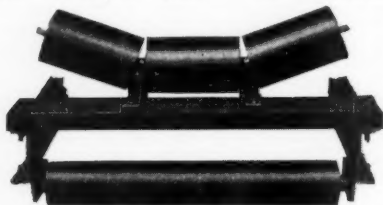


GRAVITY FEED WEIGHING MACHINE
Capacity 1 to 25 pounds per discharge

signed especially for use by contractors and construction forces for pumping clean or dirty water from trenches, sewers, cellars, quarries, reservoirs, barges, ships and cesspools. They are simple in construction and low in first and operating cost. The "Midget" model is equipped with a foot starter; the larger model with an easy pull starter.

New Chicago Belt Conveyor Idler

The Chicago Automatic Conveyor Co., Cicero, Ill., has brought out a new belt conveyor idler. The following



CHICAGO BELT CONVEYOR

are some of the changes which are claimed to make it a real improvement: The pulleys are spaced $\frac{1}{4}$ inch apart to avoid belt creasing. Heavy steel tubing is used for the pulleys. They have steel heads which are electrically welded flush with ends, which eliminate dust pockets.

A unit mounting is used for the ball bearings to keep them in perfect alignment. The mounting also serves as a grease reservoir. Because of the large reservoir the idlers will run from three to six months without attention. The bearings are positively protected from dust and grit by a quadruple labyrinth grease seal. This seal also prevents the grease from being thrown on the belt.

Heavy cast iron brackets are used. They are accurately machined to avoid cramping the shaft and can be mounted on either wood or channel base. There are only three places to lubricate each idler. These are fitted with alemite fittings or other types of high pressure fittings to suit plant standards.

The Marion 480 Line

The Marion Steam Shovel Company announces the introduction of a new group of 2 cu. yd. shovels—the Type 480. These machines are of the same general construction and capacity. They have uniform underframe and crawler construction, uniform boom, handle and dipper dimensions. Their crane, clam-shell and dragline equipments are uniform. They are, however, built with three types of primary power supply. The one following the longest line of historic precedent is the steam powered 480. Another is the electric 480. The last, and latest—the Diesel-Electric 480.

With 25-ft. railroad shovel type boom, 17-ft. inside dipper handle, and 2 cu. yd. dippers they follow closely the designs of the Marion Type 37. The new 480, however, is heavier, more rugged, more powerful, with better balance and having better appearance. Bearings are

bronze bushed throughout, propelling is through spur gearing at all points of heavy tooth load, a patented handle spacer prevents "bowed" dipper sticks. Sheaves and drums are exceptionally large, slide plate and yoke block is of steel and one piece.

On the electric great improvement has been made in the electrical equipment, and they have been brought so closely to steam characteristics that in flexibility and convenience of operation they are a revelation. In fact throughout a portion of the duty cycle they are superior to the steam and through another portion the equal.

The Diesel-Electric is a new development. A Winton Diesel engine direct connected to a direct current "drooping voltage" generator supplies the power for the electric motors which are geared individually to hoist, swing and crowd. From generator to dipper the Diesel Electric is a duplicate of the electric and incorporated therein are all the advantage giving features noted in connection with the electric. The Diesel engine horsepower is 150 at 750 r.p.m. The generator is 50 kw. and the hoist motor is 90 horsepower. For short periods and in typical shovel service the generator and motors will deliver several times their ratings.

The Diesel is a 6 cylinder 7"x8 $\frac{1}{2}$ " 4 cycle airless injection engine. Crank shaft has seven bearings and is of chrome nickel steel with ground journals. Starter is Winton Standard, operates at 400 pounds air pressure and is thoroughly reliable. An auxiliary gasoline engine driven air compressor is also provided as are necessary fuel oil tanks, air tanks, pumps, etc.

"Sulamite" for Core Drills

The Sullivan Machinery Co., Chicago, Ill., manufactures "Sulamite," which is the trade name for a manufactured substance developed as a substitute for black diamonds for setting core drill bits. Sulamite is a metallic alloy having practically the same characteristics as carbon

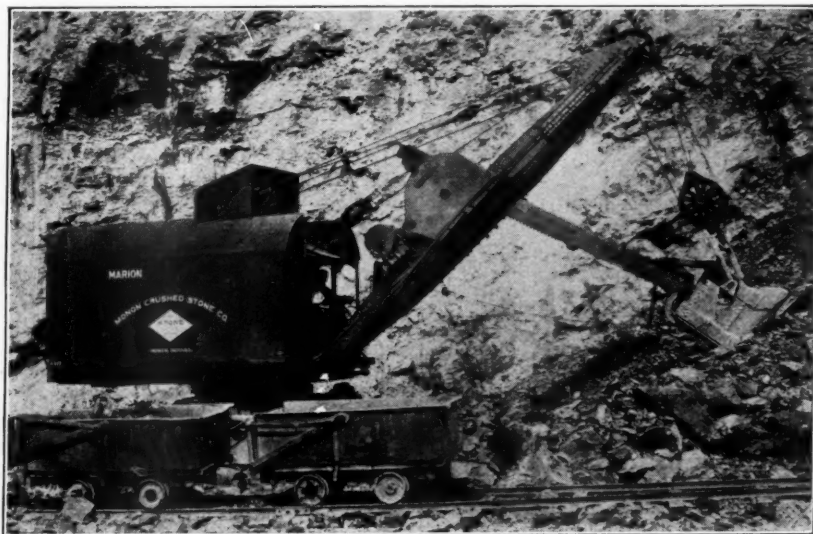
or black diamond, but is not so hard, though considerably harder than emery, corundum and similar substances.

In igneous rock, and in hard sedimentary, or metamorphic formations, black diamonds are without competition, and the same is true in sharp or abrasive rocks. In soft sandstone, soft limestone, shale, and other relatively soft sedimentary strata, "Sulamite" has been used effectively. In such cases, the lower first cost of the investment for "Sulamite" compared with diamonds, offsets the slower progress and higher cost per foot drilled. When these formations are cavey or pockety, as is frequently the case, the possibility of sticking the tools and of injury to or loss of the diamond bit, makes the use of the "Sulamite" bit advisable from the standpoint of economy. The cost of "Sulamite" per unit is very much less than that of black diamonds. "Sulamite" is furnished in cubes and also in octagonal pieces which are suited for the different sizes of bits in ordinary use. The common sizes are carried in stock.

Ligni-Salvor Wood Preserver

Wm. Menzel & Son, New York, are sole agents for Ligni-Salvor, which is a patent compound which, it is claimed, will preserve all wood treated with it from decay, rot, or fungus growth. The wood to be preserved can be dipped, soaked or painted with the material. One gallon of Ligni-Salvor will cover about 300 square feet of dressed lumber. It must not be mixed or diluted with other substances. It comes in one color, chestnut; it emphasizes the grain or fiber of the wood, and becomes more beautiful as it ages. It is claimed that it will not peel, blister, crack, scratch nor wash off. There is an odor at the time of application, which disappears entirely in 2 weeks or longer, depending upon temperature, weather and ventilation.

Ligni-Salvor is stated to be especially valuable as a preventive of dampness and for use where wood is exposed to severe wear or weather conditions.



MARION TYPE 480 SHOVEL

Link-Belt $\frac{3}{4}$ -Yard Shovel-Crane-Dragline

Link-Belt Company, Chicago, Ill., announces adding to its line a heavy-duty $\frac{3}{4}$ -cubic yard size of crawler shovel-crane-dragline, known as Type K-25.

With the addition of this and the heavy-duty 2-cubic yard size announced last summer, Link-Belt now offers a very complete range of sizes to choose from, any or all of which can be shipped loaded on flat cars without dismantling.

The new heavy-duty $\frac{3}{4}$ -yard size is very rugged and fast, is liberally powered, with Gasoline Engine, Diesel Engine, or Electric Motor drive, as desired, and is very easy to operate.

As a shovel, it is equipped with $\frac{3}{4}$ -yard struck-measure capacity dipper. As a dragline or crane, it will handle a $\frac{3}{4}$ -cubic yard bucket on a 40-foot boom.

Features of interest are: One-piece annealed cast steel lower frame; one-piece annealed cast steel rotating base; self-cleaning chrome steel crawler treads; large bronze-bushed crawler rollers; totally enclosed lower-frame travel gears, running in oil; full steel house enclosing operator and the machinery; unusual accessibility, and comfort for operator; quick and easy convertibility from shovel to crane, dragline, trench hoe, etc., or vice versa, without changing or disturbing the mechanism of the machine proper.

Lauson Vertical Air Cooled Engine

The John Lauson Mfg. Co., New Holstein, Wisc., has brought out a vertical air cooled engine to fill the increasing demand for a motor built on automotive lines, not too heavy in weight, and with working parts substantial enough to give continuous service. The crankshaft is mounted in high grade heavy duty roller bearings which are lubricated from the engine crankcase. The crankshaft is 1 $\frac{3}{8}$ inches in diameter, balanced with counter weights which reduce vibration to the minimum. The camshaft is one piece, drop-forged, hardened and ground, and is mounted in large bronze bearings. Connecting rods are interchangeable with

Ford model T rods. Grey iron piston is used, specially designed for high speed performance and equipped with three rings.

The lower base of the engine forms an oil reservoir from which the oil is raised by a submerged plunger pump driven by an eccentric on the camshaft. The oil is distributed to all vital parts of engine by splash system. Ignition is by high tension Wisco magneto, specially designed for high speed motors, driven by helical cut gear from the camshaft and operated at camshaft speed. The spark plug is mounted in the head, directly in the combustion chamber.

The Marion Type 450 Line

The Marion Steam Shovel Co., Marion, O., has brought out a new group of Type 450 shovels. The trend of the industry is towards greater capacity and in line with this tendency Marion supplies the 1 $\frac{1}{4}$ cu. yd. shovel where a few years ago the $\frac{5}{8}$ or $\frac{3}{4}$ cu. yd. would have been quite satisfactory. One of the features of this development is that despite the larger bucket, greater weight, more sturdiness, more powerful motor—gas or electric—but little more space is required. The new units operate in the restricted quarters necessary to the old.

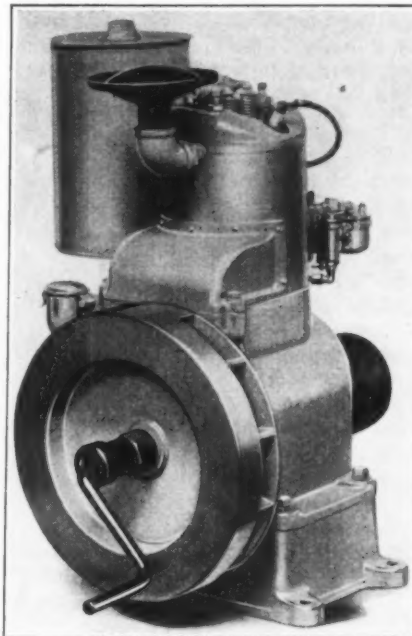
The design follows closely that of the Type 7, 1 cu. yd., which the Type 450 supersedes. There are electric and gas-electrics and Diesel-Electrics. The underframes are uniform. Booms are 22-ft. and handles are 15-ft. Houses are uniformly of steel. Boom hoist is standard equipment.

Crawlers have been lengthened about a foot to provide the additional stability necessary to the larger power plant and larger dipper. Base frames have been strengthened.

All carry the latest developments of the electrical equipment manufacturers and in addition have several features perfected and patented by Marion engineers. They have the flexibility of operation and convenience usually at-

tributed to the steamer only. Throughout a portion of the duty cycle they are superior to the steamers while through another portion they are their equals.

The Gas-Electric employs a 92 H.P. gasoline engine to drive a 25-kw. (continuous rating) direct current "drooping voltage" generator which supplies current to the three motors so necessary to flexible and convenient operation. From the generator towards the



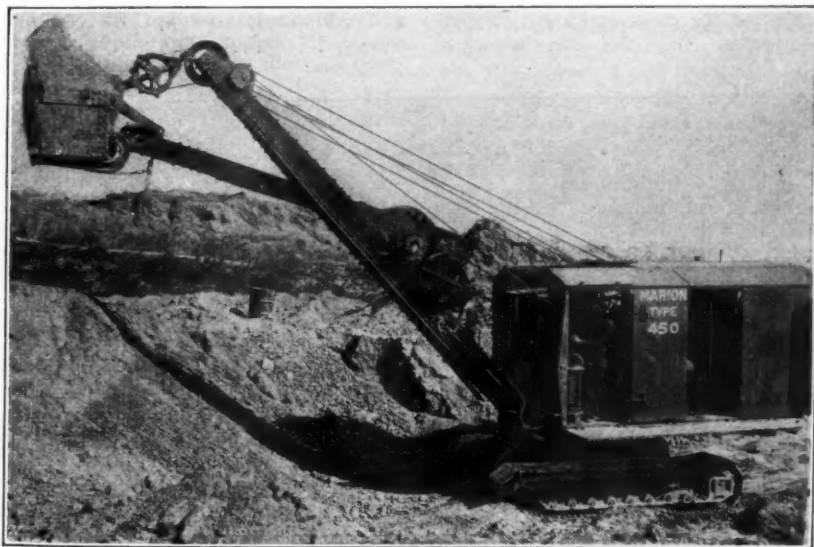
LAUSON VERTICAL ENGINE

dipper the gas-electric is a duplicate of the electric. Hoist motors are 30 hp., 60 min. rating, and swing and crowd motors are 12 $\frac{1}{4}$ hp., 60 min. rating.

The Diesel-Electric has for its power plant a Buda M. A. N. 92 hp., 1,000 R.P.M. Diesel with all the necessary accessories—fuel pump, water pump, fuel oil filter, lubricating oil filter, starter, etc. The Diesel is 4 cylinder, 4 cycle, solid injection and has a 5 bearing crank shaft. It is direct connected as in the gas-electric shovel—to a 25 kw. "drooping" voltage D.C. generator from which point towards the dipper it is a duplicate of the electric or gas-electric.

Marion Wire Form Tightener

The Marion Malleable Iron Works, Marion, Ind., manufacture a tightener made expressly for tying cement forms. The tightener is attached to a wire slipped through from one side of the form and a bolt is screwed into it from the face side. This bolt allows any degree of tension and permits bringing the form into perfect alignment. After the concrete is set the bolt is easily withdrawn and the small hole may be stopped with a slush of cement leaving a smooth surface to the wall, with no wires protruding and no possibility of rust streaks. The wire form tightener is made in five sizes, threaded to take $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1 inch bolts.



MARION TYPE 450 SHOVEL

Link-Belt Silent Chain Drive

The Link-Belt Co., Chicago, Ill., has announced that, because of increased demand, the range of silent chain drives from stock have been raised to 60 h.p. Four years ago, these were first made available in sizes from $\frac{1}{2}$ to 10 h.p.; in 1926, the range of horsepower was increased to 15. Now, according to their latest silent chain publication, Book No. 725, it will be possible to obtain drives as high as

The winch mounted with the compressor on the 10/20 McCormick-Deering tractor will be shown at the Road Show at Cleveland, booth NEH-24.

The Bartlett-Snow Concrete Truck Body

The C. O. Bartlett & Snow Co., Cleveland, O., has brought out a ready mixed concrete body which is made with its two sides movable; that is, when concrete is

tical position, it forms an ordinary rectangular end dump body in which sand, gravel, etc. may be carried.

The Bartlett-Snow body performs the function of correcting any separation to the complete satisfaction of every engineer who has inspected it, and tests taken at wide intervals prove that the concrete delivered in the body up to the time limit set by cost is in every respect equal to that delivered by the mixer at the central plant.

The Bartlett-Snow body costs less than any similar purpose body now offered. It fits any truck; it has no revolving parts to wear; it requires only one minute to correct separation and dump the load upon arrival at the job; only a few seconds are required to load, meaning the maximum number of hauls; it weighs less than any other body.

Simplicity of design, efficiency, sturdiness, and economy make it an extremely popular body. It can be mounted on any chassis.



BARTLETT-SNOW CONCRETE BODY

60 h.p., in practically any reduction from 1 to 1 to 7 to 1, for immediate delivery, by distributors in the principal cities of the United States.

The "drives from stock" plan does not in any way affect the range of horsepowers available in the silent chain engineering drives which this company furnishes to industry in general, in drives up to 1,000 h.p. and over.

Link Belt Company's production of silent chain drives is entirely concentrated in one plant—the Dodge Works, at 515 N. Holmes Ave., Indianapolis, of which James S. Watson is manager.

being transported the side plates are "V" shaped, and upon arrival at the job the plates are wound horizontal. This action corrects any segregation of mass and fluid that may have occurred during the journey. No mechanical agitation of any kind is required to condition the wet mix before unloading.

The body is then tilted and the mix is again churned as it passes through the end gates. The concrete which pours from the tail piece is as plastic and workable as when it left the mixer.

There are no mechanical baffles or obstructions of any kind inside the Bartlett-Snow body. This feature makes it very suitable for the additional duty of general hauling. With the sides in a ver-

INDUSTRIAL NOTES

L. J. Kanitz, manager of the industrial division of the Continental Motors Corporation, announces the appointment of Sid Harris as industrial sales engineer in the East.

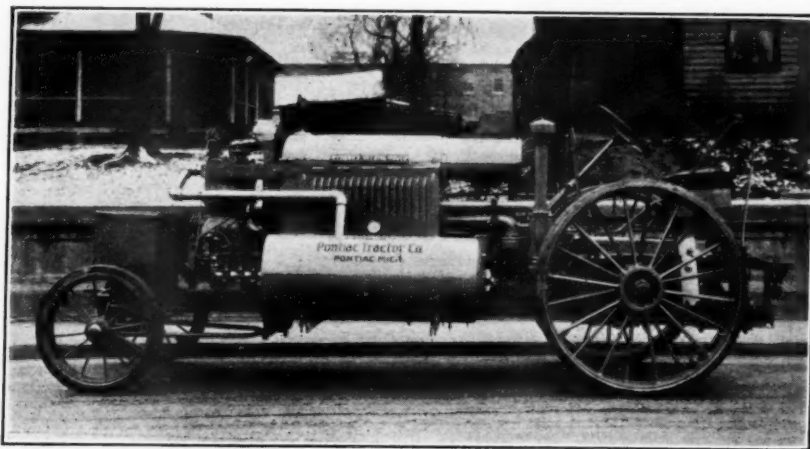
Harold C. Osman, secretary of the Nugent Steel Castings Company, Chicago, and heretofore in charge of sales for that company, has been appointed works manager.

The New York sales office and display room of The C. F. Pease Company, Chicago, formerly located in the Grand Central Terminal, New York City, has been moved to the 7th Floor, Ashforth Building, at 12 East 44th Street, New York City.

The Pennsylvania-Dixie Cement Corporation announces the appointment of Walter S. Wing as general sales manager. In his new position Mr. Wing will be in general charge of the marketing of the corporation's products and will be located at 131 East 46th Street, New York City.

Pontiac Backfiller Winch

The Pontiac Tractor Co., Pontiac, Mich., has announced a backfiller winch which operates in connection with the McCormick-Deering tractor. The backfiller winch is designed to mount with either of the units made by this company, and when mounted with the compressor allows the operations of backfilling and tamping at the same time. These give a unit-designed self-propelling machine, with the draw bar free for hauling other equipment. The backfiller winch has a single drum with clutch and brake and takes its drive from the power drive shaft at the rear of the tractor, and is mounted on the frame at this point. This unit can be operated from either side of the tractor and is controlled from the driver's seat.



PONTIAC BACKFILLER WINCH

The Wagner Electric Corporation of St. Louis, Missouri, announces that F. T. Coup, in charge of the Cincinnati office since 1921, has been moved to Milwaukee office as branch manager there.

The Trackson Company, Milwaukee, Wis., manufacturers of Trackson Full-Grawlers, Loaders, Shovels, Cranes, etc., announce that they have arranged with the Browning-Ferris Machinery Co., 205 Exposition Ave., Dallas, Texas, for the distribution of Trackson equipment for McCormick-Deering Tractors.

These distributors will have the entire state of Texas for their territory. They also have branches in Houston, Fort Worth, and Amarillo. They are authorized distributors for McCormick-Deering Industrial tractors, and are in a position to give quick service on the International and Trackson lines.

The Caterpillar Tractor Company, of San Leandro, Calif., announced December 13th that it had acquired the business and facilities of the Russell Grader Manufacturing Co. The Russell line of road building machines will hereafter be manufactured by the road machinery division of the Caterpillar Company at the plant formerly occupied by the Russell company at Minneapolis.

Caterpillar Tractor Company dealers will handle the sale of Caterpillar tractors, Russell Road Machinery and Holt combined harvesters, the last being produced by the harvester division of the Caterpillar company, located at Stockton, Calif. The company has announced its intention to build an eastern combined harvester factory at Peoria, Ill., where its principal tractor plant is now located.

The Trackson Company, Milwaukee, Wis., manufacturers of Trackson Full-Crawlers, Loaders, Shovels, Cranes, etc., announce the appointment of the following distributors: Brinker Supply Co., 905 Clark Building, Pittsburgh, Pa., and R. L. Stockard & Son, 2302 Charlotte Ave., Nashville, Tenn.

The Trackson Company, Milwaukee, Wisconsin, announces the recent appointment of the following distributors in southern territories: Dealers Equipment & Implement Company, P. O. Box 2281, De Soto Station, Memphis, Tennessee; Evans Implement Company, 569-71 Whitehall Street, Atlanta, Georgia; F-D Equipment Company, 4219 East Grand Avenue, Dallas, Texas; Industrial Tractor & Equipment Corp., 409 North Fifth Street, Richmond, Virginia; Industrial Machinery Co., 1717 Main Street, Kansas City, Missouri; and Southern Equipment Company, Inc., 501 North Alexander Street, New Orleans, Louisiana.

The W. A. Riddell Company, manufacturers of Warco road machinery, has established a branch at North Little Rock, Arkansas. O. E. Tapley has been appointed branch manager. Formerly of the Arkansas State Highway

Department, he is well known among road men, contractors and highway officials throughout the state. The North Little Rock branch will carry a full line of Warco products, including graders, road rollers, wheeled scoops, full and semi-crawlers, and crawler-ized tractors.

L. S. Shaffer has joined the organization of the C. O. Bartlett & Snow Co., of Cleveland. Mr. Shaffer was formerly general manager of Byers Machine Co., Ravenna. He will be in charge of the sales and development of the truck body Bartlett-Snow are building for the transport of pre-mixed concrete. The sale of this body will be handled outside of the regular Bartlett-Snow sales organization, the present plan being to distribute this product entirely through dealers in contractor's equipment and through manufacturers of motor trucks.

Due to a 62% increase in Lorain-75 sales of The Thew Shovel Company, that company has found it necessary to add to their sales force.

J. H. Devine, who will be located at the company's Chicago office; A. L. McLain, who will be attached to the Dallas, Texas office; G. D. Laurell, with residence at Alcoa, Tenn., who will be attached to the Atlanta Office in a sales capacity for both The Thew Shovel Company and The Universal Crane Company; H. S. Beale, who will be located at The Thew Shovel Co.'s New York Office; R. S. Delp, at the Philadelphia Office, and Malcom Jones, at the Chicago office. The following is a list of new representatives which will have the Sales and Service Representation in their respective territories: The Southern Tractor Company, Montgomery, Ala.; the North Carolina Equipment Co., Raleigh, N. C.; the Hall Perry Machinery Co., Butte, Mont.; the Paragon Supplies, Ltd., Vancouver, B. C., Canada; the Jennison Machinery Co. (Successors to Smith Booth Usher Co.), San Francisco, Calif.; and the R. G. Moeller Co., Detroit, Mich.

Loder and Sharp, Inc., Philadelphia, FWD truck dealer, has been awarded an order by the Pennsylvania State Highway Department for 54 FWD four wheel drive dump trucks designated as the FWD Commercial Utility model which is of 3 tons capacity. The trucks are to be equipped with six cylinder motor, electric lights and starter, five speed transmission, pneumatic tires, cab, dump body and hoist. A special feature of the truck is the unusual low mounting of the dump body which has been developed during the past year. The head lamps are to be mounted on the cab to permit snow plowing as the trucks are to be used in all year round road maintenance.

The Trackson Company, Milwaukee, Wis., manufacturers of Trackson Full-Crawlers, Loaders, Shovels, Cranes, etc., announces the appointment of the

following Distributors who will handle their lines of Trackson equipment; Industrial Tractor Sales Co., Inc., 500 Fallsview, Baltimore, Md.; E. B. Kelly Co., N. Broadway, Box 22, Albany, N. Y.; W. B. May, Inc., 41 Perry St., Buffalo, N. Y.; Truck-Tractor Equipment Co., 460 Neilston St., Columbus, Ohio; Tractor & Equipment Co., 520-522 Passaic Ave., Newark, N. J.; and Service Supply Co., 20th and Venango Sts., Philadelphia, Pa. The Motor Power Equipment Co., Ford Road and River Blvd., St. Paul, Minn., has also been appointed a distributor and will handle all Trackson lines of equipment for the McCormick-Deering Industrial Tractor.

The Sweet's Steel Company of Williamsport, Pa., have announced the following appointments to take effect immediately: Samuel C. Rebman, who has represented the Sweet's Steel Company in the capacity of district sales manager in the Pennsylvania anthracite coal fields, is now transferred in the capacity of sales manager to the branch office of this company located at 274 Madison Avenue, New York City; Hugh G. Daley, formerly with the Carnegie Steel Company, has been appointed sales manager in charge of the Pennsylvania anthracite coal fields, and will be located in the company's branch office, 733-734 Land Title Bldg., Philadelphia, Pa.

C. V. Witt, president of the Witt-Humphrey Steel Company, Greensburg, Pa., announces that his company has been successful in securing one of the largest water pipe contracts ever awarded. The pipe line is for the Bureau of Water of the City of Philadelphia and consists of 7 miles of 8-foot and 6-foot diameter steel pipe. The pipe will be shipped from Greensburg in sections 38 feet in length, each section weighing about 26,000 pounds.

This contract will require about 1,000 freight cars as the size of this pipe will permit the loading of only one pipe section to a car. The steel plates from which this pipe will be manufactured are 9/16 inch thick and the total plate tonnage required for this contract will be approximately 20 million pounds.

The pipe will be protected against corrosion by being dipped vertically in a bath of special refined asphaltum and inasmuch as the Witt-Humphrey Steel Company had installed in their new pipe works at Greensburg one of the largest electrically heated dipping tanks in the country, they were in a position to fulfill the specified requirements for the dipping of such large pipe. Shipments of this pipe will begin about January 1, 1929.

The above company is now building at their works in Greensburg a pipe line for the City of Detroit, also 8 ft. in diameter, which contract will be completed in December.

Exhibits at the Road Show

Short Descriptions of Some of the Exhibits Shown This Month at the Cleveland Road Show

Austin-Western Exhibit

The Austin-Western Road Machinery Company, in Booth No. WW-111, will exhibit seven pieces of equipment. Three of these are of special interest because they represent entirely new developments in the road machinery field.

First and foremost will be the Austin Dual Drive Motor Grader which has already caused much interested comment.



AUSTIN DUAL-DRIVE GRADER

The model exhibited will be built around a McCormick-Deering 10-20 power plant.

Among other things, the Dual Drive provides more power than has ever before been obtained from a similar power plant—greatly increased traction—less wear through the elimination of friction—and the ability to operate over softer, wetter ground than has been possible with two-wheel drive machines.

Another entirely new machine, being displayed for the first time, is the Austin

Cadet, a 5-ton, factory built pup sized roller very similar in appearance to the well known 10-ton Austin Autocrat. Its exceptionally short wheelbase permits great freedom in operating between forms and the Cadet transmission with 3 speeds forward and reverse gives increased handling ease. This feature is impossible to attain when standard tractors are used for power plant.

A third innovation is the Western 5-yard Crawler Wagon. In design this closely follows the Western 7-yard and 10-yard Crawler Wagons. The advantage of the smaller wagons with the same features (easy dumping and ability to work over any ground regardless of its condition) possessed by the larger wagons will be apparent to everyone interested in earth handling.

Other machines displayed will include the 10-ton Austin Autocrat Roller with Power Steer and Scarifier—the Austin Mammoth Senior Leaning Wheel Grader with Rip-Snorter Scarifier—the Western No. 55 Grader with Scarifier—and the Western Motor Grader attachment for the No. 20' Cletrac, with front Scarifier and Cab.

The exhibits will be in charge of William Cornwell.

Cleveland Tractor Company

The Cleveland Tractor Co. will occupy booth WW-89, and will have headquarters at the Hollenden Hotel. On exhibit will be the entire line of tractors, comprising the "20," "30," "40" and "100" models. In addition there will be a cut-out chassis, a duplicate of one of the Model "40" Cletracs which was selected by Commander Byrd for the South Pole Expedition and parts displays such as are usually found in exhibits of this kind.

The company is arranging again to set aside one of its buildings out at the factory in which will be exhibited all kinds of road construction, maintenance and contractors equipment such as is used with tractors generally. A buffet lunch will be served here at the plant throughout the entire day, as last year, and free buses will be provided to bring the visitors out to the factory and take them back down town.

Dodge Brothers Trucks

The entry of Dodge Brothers into the heavier truck field will be featured in their exhibits at the American Road Builders Association convention. The 3-ton truck on a 135-inch wheelbase chassis is to be shown in three models with hydraulic hoist and dump bodies.

These trucks are all now designated as Dodge Brothers trucks. They were



CLEVELAND TRACTORS

NO RAMPS TO REMOVE BY HAND—FOR THE VERTICAL BOOM DIGS STRAIGHT DOWN

The Man Who Bossed the Crew Now Does All the Digging

"By the hand shoveling method, it was necessary to have a man in charge, just to keep the crew moving. Now we put the same man on a Barber-Greene Ditcher and make him do all the digging."

That's how one ditching contractor explained how the Barber-Greene Vertical Boom Ditcher cut his costs to the core.

Instead of the wages of a shovel gang, he now has a one man payroll to meet.

For, without the aid of expensive hand shovelers—without costly breakdowns or delays—the "milling" action of the

Barber-Greene Vertical Boom chews its way through frozen ground, coral rock, hard pan, macadam, caliche, sticky clay, and root filled ground—at a speed that knocks the bottom out of high ditching costs.

And because the vertical boom digs straight down, and comes straight up, there are no ramps to remove by hand.

"Ditching Snapshots and Records" describes Barber-Greene Ditchers in detail and shows them operating on all kinds of jobs. In addition, complete service records and cost figures show exactly how much was saved on each one. Send for your copy today.

Barber-Greene Company, 635 Park Ave., Aurora, Illinois

Vertical
Boom

Barber-
Greene

DITCHER

Four to Seven Feet Maximum Depths
Standard Widths: Eighteen to Twenty-four Inches
Also, Conduit and Curb and Gutter Specials

Please mention PUBLIC WORKS when writing to advertisers.



DODGE BROS. TRUCK WITH 3-WAY BODY

formerly known as Graham Brothers but in future they will carry the name of their makers, according to a recent announcement made by officials of the company. The entire line of trucks, buses and motor coaches built by the company is included in the change of name.

One chassis fitted with a 3-way dump body is designed to fill practically every need of the hauler. The manufacturers point to its ease of operation, economy, versatility and safety as features particularly important in road building and maintenance work. Its downfolding side doors operate automatically, lowering as the body dumps, throwing material well clear of the wheels and locking again as the body resumes its normal position. A saving of time is effected as the necessity of maneuvering into a dumping position is eliminated, the body dumping from the rear or either side as required. Its hoisting unit consists of a triple telescoping lift with massive ball and socket joints, permitting a rocking motion in any direction.

Another chassis is equipped with a Heil body and snow plow. A full length running board on this model serves as mudguards for the wheels while other features include a double acting tail gate. The hoist is of the twin-cylinder hydraulic type. The third type to be shown is a body with straight sides and square corners.

The prices of the new chassis range from \$1,745 to \$1,970 f.o.b. Detroit. The equipment includes speedometer, ammeter, radiator shutters, thermostat, water temperature indicator, oil pressure gauge, crankcase ventilator, gaso-

line and oil filters, and air cleaner. Four speed heavy duty transmission and Lockheed hydraulic internal expanding brakes are used.

Dodge specifications are followed throughout, the body manufacturers using designs especially adapted to the requirements of the road contractor. Those to be displayed are products of the Wood Hydraulic Hoist and Body Company of Detroit; the Heil Co., of Milwaukee, and the Differential Steel Car Company of Findley, Ohio. The chassis are built by Dodge in three models with a variety of tire and wheel equipment to meet all requirements: 34 x 7 front and 36 x 8-inch rear tires; 32x6-inch tires all around and 34x7 all around. The latter two types have dual wheels at the rear, available in either the cast spoke or disc type. Two 2½ and a 2-yard body are to be shown.

Mohawk Asphalt Heater Co.

The Mohawk Asphalt Heater Company, Schenectady, N. Y., has a carload shipment of ten "Hotstuf" Combination Tool and Asphalt Heaters filling one order from one of the largest and most representative pavement contractors in the East. This contractor purchased one "Hotstuf" Tool Heater on trial approval and has standardized on and entered his order for ten units.

The "Hotstuf" Combination Tool and Asphalt Heater has a tool heating compartment of more than sixteen tools such as tampers, smoothers, rakes and shovels.



RECENT SHIPMENT OF "HOTSTUF" TOOL AND ASPHALT HEATERS

Insley Manufacturing Co.

The Insley Mfg. Co., Indianapolis, Ind., will show an Insley Type "R" shovel, and an Insley Type "C" skimmer. This Type "R" shovel is a recent production and has not previously been shown at a road show.

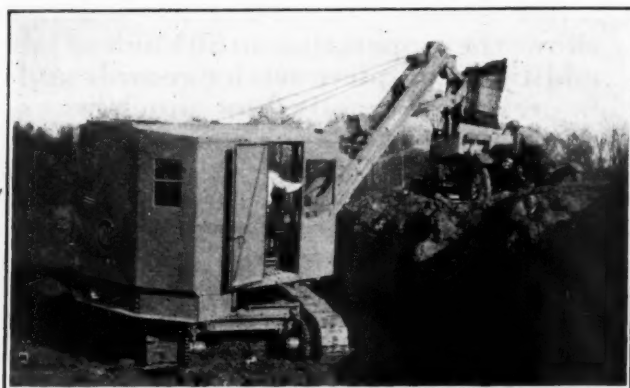
Carl S. Wagner, sales manager of the company, will be in charge of the exhibit.

Bay City Dredge Works

The Bay City Dredge Works will exhibit three separate and distinct machines this year in the Central Armory Building, space AY-9, the same location held last year. A brief description of these machines follows:

Model R ¾ yard full circle. This heavy duty full revolving machine was designed and announced this summer. It is a 25 ton full crawler mounted, full revolving convertible excavator featured with shovel, clamshell, drag line, skimmer or trench hoe buckets. It is equipped with Climax 65 H. P. engine with electric self starter and has a number of features not found on other full revolving equipment including a 6-foot diameter swing circle which eliminates rocking or tipping on the center pin. The base of the boom is located on 30 in. from the center pin giving this machine unusual stability.

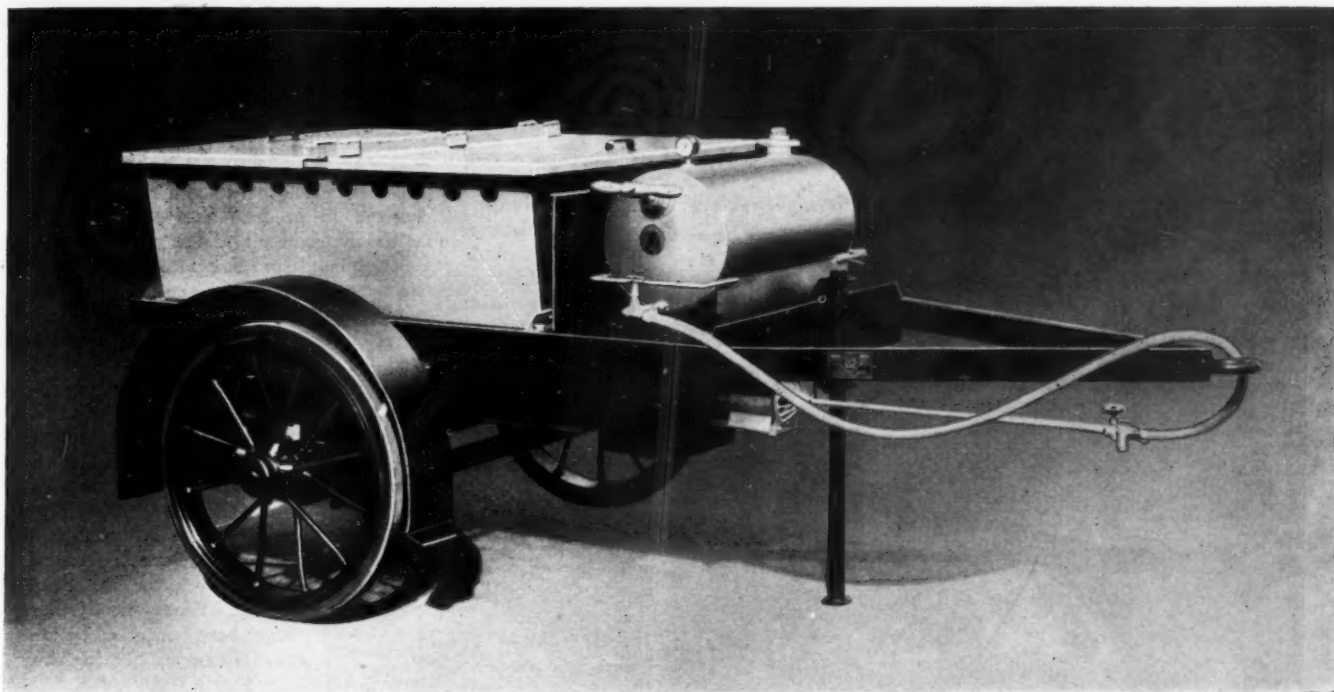
The Bay City Tractor Shovel, two models of which were displayed last year, will again be exhibited at Cleveland with shovel, boom and bucket. This is a fast moving and operating full crawler convertible shovel operating clamshell, drag line and trench bee in addition. It is powered by the McCor-



INSLEY MODEL "R" SHOVEL



BAY CITY TRACTOR SHOVEL



NO. 84-W FOR 1929

An oil burning tar and asphalt kettle by Littleford—made in 50, 75 110 and 165 gallon sizes.

AN OLD KETTLE and a New Year

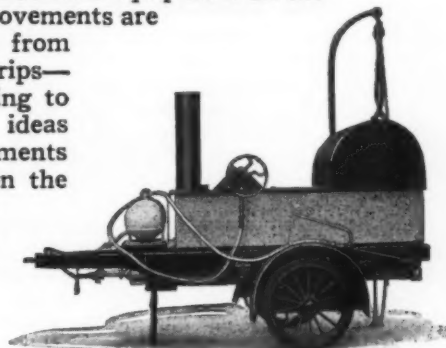
The past four years have seen a very decided growth in the popularity of the oil burning tar and asphalt kettle. Highway engineers have found that maintenance gangs can accomplish more when an oil burning kettle is the source of supply. Contractors know that oil burning equipment brings greater profits.

The Littleford No. 84—W Tar and Asphalt Kettle (featured above) has, to a large extent, been responsible for the confidence shown by road men in oil burning equipment. Each year improvements have been made in them—improvements that mean increased efficiency—improvements that highway engineers themselves suggest to us. For example: The 1929 model has a new double hinged cover that can be opened at either end or entirely removed from the kettle—it can be fastened down securely to prevent splashing of material as the outfit is trailed. Another improvement is a new baffle arrangement at the top of the melting kettle which further prevents splashing and eliminates danger of catching the batch on fire.

There is a definite reason for the favor shown by highway engineers and contractors toward Littleford equipment. Every year we conduct a thorough inspection trip—we visit street and highway departments—we talk to contractors and see our equipment on the job. The improvements are

direct results from these yearly trips—we leave nothing to chance; new ideas and improvements are obtained on the highways and in the cities through contact with users.

In this, our first advertisement for 1929, we sincerely wish you a happy and successful New Year.



NO. 78-OB

The 300 gallon Trail-O-Heater equipped with cover for Hand Spraying Attachment—a Littleford feature exclusively.

LITTLEFORD BROS.

452 East Pearl Street

Cincinnati, Ohio


LITTLEFORD
ROAD & STREET MAINTENANCE
EQUIPMENT

L I T T L E F O R D K E T T L E S S I N C E 1 9 0 0

Please mention PUBLIC WORKS when writing to advertisers

mick Deering Industrial Tractor and mounted with long full crawlers. It travels at speeds up to four miles an hour under its own power.

The third Bay City machine will not be mentioned by name or illustrated prior to its display at the Road Show. This machine is intended as a surprise to the contracting profession and no further information is available at this time



ARMCO IN LANDSLIDE PREVENTION

other than it will be a small, fast, full revolving machine with six different bucket attachments, full crawler mounting with buckets of 3-8 to 1-2 yard capacity. The machine will weigh approximately 13 tons. Car body and machinery base are of hi-manganese unit steel castings. Many special features including a patented propelling and steering mechanism eliminating all square jaw clutches and machinery below the car body, is one of the many attractive features.

Armco Exhibit Features Highway Subdrainage

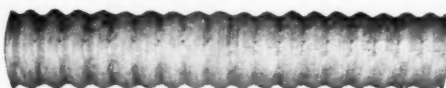
A recent development in highway work is a growing realization of the importance of subdrainage and the greater use made of it in protecting roads. This detail of highway design affects the stability of pavements and structures and is frequently a factor in the control of landslides.

Because of the importance of this subject the central feature of the exhibit of the Armco Culvert Manufacturers Association, Middletown, Ohio, at the National Good Roads Show, Cleveland, is Armco Perforated Iron Pipe, a product especially designed for subsurface drainage. This pipe, which is corrugated iron perforated in the valley of each corrugation for a portion of its cir-

cumference, is well adapted to subdrainage problems because of its great strength, its safety against surface impact and frost action, its resistance to disjuncting, and its high drainage capacity.

Evidence presented of the efficiency of Armco Perforated Pipe includes installations involving landslide prevention along highways and railways, protection of bridge abutments, stabilizing of roadbeds, golf course improvement and airport drainage. The satisfaction obtained from this type of drainage is due to its uniform dependability and freedom from trouble.

Another highway problem which has been given attention by Armco engineers is that of culvert erosion, it having been found that culverts of all types wear out first in the bottom because of the scouring action of the stream. Often the bottom will be entirely gone while the rest of the structure is unharmed. The solution developed by Armco engineers for this problem is a culvert of balanced de-



ARMCO PERFORATED PIPE



ARMCO PAVED INVERT CULVERT

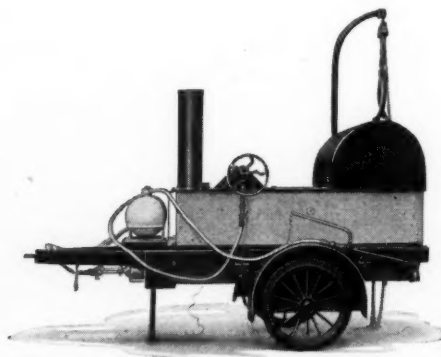
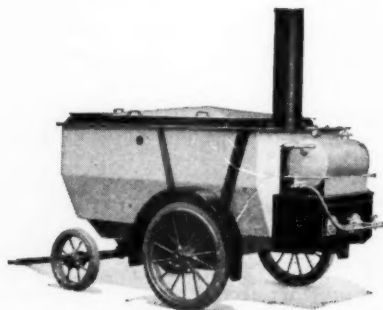
sign in which the entire structure is given a uniform life throughout. The bottom is reinforced against its concentrated wear by a specially developed and exceedingly tough, yet heat resistant bituminous pavement. This product is the Armco Paved Invert Culvert which is also exhibited at this show.

The Armco display is in space EH-17 with Anton S. Rosing, publicity manager in charge. Others in attendance are W. F. Moehlman, J. S. Neibert, T. M. Neibling, H. J. McKeever, W. H. Spindler, and Dr. G. E. Ladd.

on the interior of the box extends full length. Another shelf, just in front of the box and between the channels forming the chassis, serves as a work bench.

It is mounted on the Littleford 2-ton trailer and can stand hard trailing.

Further improved is the Littleford large capacity No. 83 Oil Burning Tar and Asphalt Kettle. It has a newly designed combustion chamber that is said to be about as near to being proof against intense heat as is possible to make. Special analysis fire-box steel and Sil-O-Cel insulation are used in the construction.



LITTLEFORD BROS. ROAD BUILDING EQUIPMENT

Littleford Bros.

Littleford Bros., Cincinnati, O., have regular equipment exhibited at their booth at the Road Show, including the 84-W hand-spraying attachment.

Several important changes have been made in this. The whole construction has been strengthened and the gear ratio changed to produce a stronger flow of melted material. The new cover designed for the hand-spraying attachment makes it a part of the kettle; the kettle is completely covered at all times. Many highway departments have used this attachment on penetration patching and shoulder work. It is a valuable auxiliary for a large pressure distributor and can efficiently care for out-of-the-way patches and uneven shoulders that cannot be reached by the large distributor.

The 1929 Trail-O Heater has a lower center of gravity, a newly designed combustion chamber made of special analysis steel and the new cover for the hand-spraying attachment. Forty-one of these new kettles have been ordered by the State of Texas for use in her highway department.

The Littleford Portable Tool Box is a surprise and will undoubtedly meet a real need among highway engineers and contractors. The box is constructed entirely of steel and is absolutely waterproof. It is 45 inches wide, 8 feet long and 20 inches high, sloping to 25 inches in the center. A strongly built shelf

WATER SUPPLY . . . FIRE PROTECTION . . . SEWAGE DISPOSAL



Easier Quicker Safer

ONLY UNIVERSAL PIPE LINES are 100% cast iron. The pipe is cast iron. Its flexible machined iron-to-iron joint—an integral part of the pipe line—is cast iron. Cast iron lasts for centuries.

No hot lead, no cold lead, no lead substitutes. No pouring, no calking. No bell holes to dig. Curves laid with straight lengths. *Every joint as tight as the wall of the pipe itself.* Wrenches the only tools.

[[UNIVERSAL PIPE LINES STAY TIGHT
... because the joint as well
as the pipe is 100% cast iron]]

UNIVERSAL CAST IRON PIPE

No bell holes to dig: No joints to calk

THE CENTRAL FOUNDRY COMPANY

Subsidiary of The Universal Pipe and Radiator Company

Graybar Building, 420 Lexington Avenue

Chicago Birmingham New York Dallas San Francisco

Good News!

SERVICE BOXES
WITH STAY-ON
COVERS

No more broken covers.
No more lost covers . . .
Interchangeable with
"Buffalo" boxes . . .

Ask for MONITOR
SERVICE BOX
booklet.

1001

Put your water supply, fire protection and sewage disposal problems up to our nearest office:
New York, Graybar Building, Lexington Avenue at 43rd Street (adjoining Grand Central Terminal) . . . Chicago, McCormick Building . . . Birmingham, Comer Building . . . Dallas, Praetorian Building . . . San Francisco, Rialto Building

Please mention PUBLIC WORKS when writing to advertisers.

Wherever large quantities of melted tar or asphalt are needed, No. 83 is made in 300 and 550 gallon capacities. The two large Torch-Type Oil Burners are capable of melting an entire batch of material in less than two hours.

Anthony Rotating Power Hoist Body

A new single batch capacity dump body for light duty trucks will be introduced at the Road Show, Cleveland, Ohio, by the Anthony Company of Streator, Illinois, and will be an addition to their Roller Rocker gravity line.

Deriving its lifting power from the motor through a power take-off, the new model is known as a Rotating (power driven) Hoist. Application of this power is simple and easy. Lack of complicated parts with their attendant need



ANTHONY ROTATING POWER HOIST BODY

for replacement is an outstanding feature in its construction. Low loading height and increased loading area in the box has been endorsed by leading paving contractors of the country. The general characteristics, such as electric welding, one piece boxes, structural steel under-structures, double acting tailgates, high dumping clearance and ample underbody cross braces, conform to the Anthony standards.

The Anthony Company will exhibit in Booth 61-West Wing. W. C. Anthony, president; R. R. Howard, sales manager; W. V. Tomlinson, J. H. Monning, E. S. Krieger, E. L. Flanagan and C. F. Hartman will represent the company and will be registered at the Statler Hotel.

Wood Hydraulic Hoist and Body Company

The Wood Hydraulic Hoist and Body Company's exhibit at this year's Good Roads Show will be unlike that of any preceding year. A complete line of working models—scaled to one-third size—will be shown in place of the larger units. These miniatures will be electrically operated, enabling the visitor to get a comprehensive idea of the method of operation of Wood Hoists and Bodies.

Announcing the exhibit will be four large Neon signs arranged rectangularly so the name "Wood" will be visible from all sides.

Miniatures will depict the Slant Type Underbody Hoist and Bath-Tub type Wet-Mix Body, the G-1 Hi-Speed Hoist and M-4 body; the Type M-2 Mechanical Hoist and W-12 Body; the Type M-2 Mechanical Hi-Lift and W-5 Coal Body; the "S" and "T" Gravity Dumpers and the Hydraulic Repair Tower.

C. D. Macpherson, General Sales Manager, will be in charge and various officers and members of the company will be in attendance.

The 1929 Road Show Exhibit of Universal

The New Universal—35, mounted on a 2-speed center drive crawler and equipped with a $\frac{1}{2}$ yard center drive shovel boom, will be a feature of the 1929 Road Show exhibit of The Universal Crane Company, Lorain, Ohio.

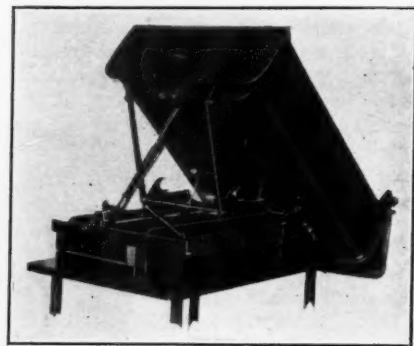
In addition to this unit, a 6-ton capacity Universal Truck Crane, mounted on a 4-wheel, 5-ton capacity White Truck chassis, will also be exhibited. This unit will be equipped with a 28 ft. boom and a $\frac{1}{2}$ -yard clamshell bucket. The boom will be fitted to show how the 4, 8 and 12 foot boom base extensions, as well as the 16-foot boom head extensions can

be applied. The 28-foot boom will also be fitted with Universal's new improved fairlead for dragline service.

One side of the White Truck mounting will be exhibited as a standard 4-wheel truck. The other side of the truck will be equipped with a Motor Truck (Christie) Crawler to illustrate how

easily this device can be added to the standard 4-wheel truck mounting.

Further demonstrations of the Motor Truck (Christie) Crawler will be made in the yard adjacent to the exhibit hall.



MODEL OF WOOD "T" GRAVITY DUMPER

A Universal Crane on a Mack Truck, equipped with the Motor Truck Crawler, will be demonstrated here to illustrate the actual performance of the Motor Truck Crawler under actual job conditions of mud, uneven ground, etc. The quick interchangeability of the unit from its 8 rubber tired wheels, used for road travel, to the full crawler rear end will also be demonstrated. In the main exhibit hall will also be found a Universal—35, Center Drive Crawler mounting. Gear guards, Treads, Crankcase, etc. will be removed to show the work-the Center Drive principle and is the ing parts. This exhibit will clearly show first time this type of Crawler Drive has been made available in the $\frac{1}{2}$ yard field.

A stripped Universal—35 superstructure will also be exhibited, arranged to show the 2-speed gears, the improved operating gear and other new developments and refinements.



UNIVERSAL "35" SHOVEL

See Our Exhibit

at the
*Cleveland
Road Show*

JAN. 14th-18th

ARMORY BUILDING
SECTION
AY-17



Trench Excavators for Every Purpose

Every practical trenching machine requirement is met exactly by some one of the complete line of Buckeyes.

From the largest to the smallest, each has definitely established its leadership of its type and class—measured by dependable service and profitable performance.

Favorite operating features that contribute to Buckeye accomplishment are these: Slow-speed, heavy-duty gasoline power unit; original power shifted conveyor—dumping on either side and readily clearing side obstructions; multiple excavating speeds, readily varied; positive bucket cleaning in any soil; digging chains of heavy manganese steel; double drive to digging chains, through differential gearing; all-steel gears, cut from solid blanks and heat treated; power steering; and Alligator (crawler) traction, equipped with brakes for controlling machine when operating on steep grades.

Thousands of these trenchers are daily giving universal satisfaction in all kinds of work—sewer, water, pipe-line, drainage, reclamation and irrigation.

Be sure to see these record-making Buckeyes at the Cleveland Road Show.

THE BUCKEYE TRACTION DITCHER CO.
FINDLAY, OHIO

There's a Buckeye Sales and Service Office near You.



Model 15 Wheel-type Ditcher

Light, fast and easily transported, it was developed especially for speedy small trench excavation, such as service and lateral gas, water and sewer lines—in cities or across country. It digs two sizes of trench, either 11½ in. wide by 4½ ft. deep or 14½ in. wide by 5½ feet deep. Proportionate to its size, Model 15 cuts little ditches just as economically as larger Buckeyes do big ones.

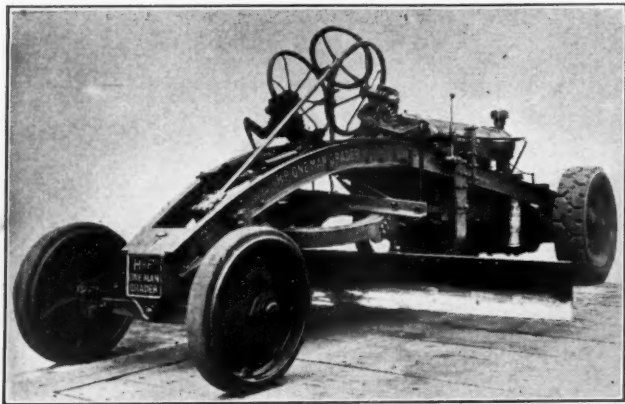
for over **Buckeye** *thirty years*

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These exhibits will be shown in Space AA4 on the Main Arena Floor of the Main Auditorium. A. W. Smythe, V. Pres. and F. A. Peck, V. Pres. will be in charge of the exhibit and announce that further Universal exhibits will be demonstrated at the Lorain, Ohio, plant. Daily bus service will be provided for interested parties.

W. A. Riddell Company Exhibit

The W. A. Riddell Company of Bucyrus, Ohio will show in Booth WW-99 their new and improved line of WARCO road building, snow removal and earth moving machinery. The unique new features of the 1929 WARCO One Man Grader will draw the attention of



RIDDELL NEW MODEL GRADER

all those interested in simpler and quicker acting road machinery.

The 1929 ALWATRAC will be most interesting to both users and prospective users of the Warco full crawler. This unit has been simplified, has greater wearing surface and will sell at a lower price than the former model.

New rear crawlers for tractors and motor graders will be shown for the first time at the Show. Power in abundance and greatly increased traction will place the new WARCO rear crawlers in the front lines, it is claimed.

The Warco wheeled scoops and motor road rollers round out the Warco line. Sales representatives of the company and Geo. M. Schmidt, General Manager, N. E. Jersey, Sales Manager, F. F. Hughes, Asst. Sales Manager, and Robert N. Schaefer, Advertising and Publicity Manager will be in attendance at the show.

Trackson Company

The Trackson Co., Milwaukee, Wisconsin, will introduce at the Road Show the new Trackson Bulldozer, mounted on the Model DH Trackson McCormick-Deering unit. This Bulldozer, which is equipped with the Trackson mechanical hoist, is described and illustrated in the *New Appliances* Section, on page 54.

Another piece of Trackson equipment, which will be shown for the first time at The Road Show is the Model LH Trackson Full Crawler. This new model of

the Trackson is designed for mounting on the 10-20 McCormick-Deering industrial tractor, and, while somewhat similar, is lighter and speedier than the DH Model introduced last year. The LH Model is fully described and illustrated on page 56 in the *New Appliances* section.

The Trackson exhibit will be shown in space WW44 at the Road Show.

Continental Motors Corporation

An extensive exhibit of industrial engines will be displayed at the Cleveland Road Show by Continental Motors Corporation. Continental's display space will be No. AA43, in the main building of the show.

Leading the list of Continental exhibits will be Model H24, one of the new series of four-cylinder, slow speed type, heavy duty industrial engines recently put into production at the corporation's Muskegon plant. These engines are designed especially for tractors, shovels, cranes, crushers and other applications where continuous, dependable duty is required.

Specifications for the new series, which is made in eight sizes show the ruggedness and practicability of the design. The engines are of the vertical valve-in-head type. Cylinder bores range from five to six and three-quarters inches. Piston stroke is six and one-half inches in the four smaller sizes, and seven and one-half inches in the larger. Horsepower ranges from 39 in the smallest engine to 125 in the largest. Recommended governed speed is 1,000 r.p.m.

Embodied in the design of this series, according to Continental engineers, are such refinements as removable cylinder sleeves, overhead valves, large crankshafts with five main bearings, dry sump oiling system, built-in governor, and longer and better proportioned pistons, all of which increase motor life and permit many more working hours at minimum cost.

Other engines on display will include Models 31R, B7, S5, P20A, P11, P10A, and P35A. This list includes a majority of Red Seal Continental models that are especially applicable to road-building purposes.

Continental Motors Corporation's exhibit at the Cleveland Road Show will be in charge of L. J. Kanitz, in-

dustrial division manager. He will be assisted by Ray Long, Arch Smith and Steve Evelyn, of the sales department, and Arch Sampson, A. D. Chandler, Stewart Nixon and Sid Harris, industrial engineering representatives.

The Barrett Company

The Barrett Company, New York City, manufacturers of Tarvia, will have as the central part of their exhibit the latest and most modern motor truck equipment for the distribution of Tarvia. Tarvia is used as the binder in the construction of penetration macadam and "Tarvia Re-Tread" roads and for the maintenance of all types of highway surfaces, except earth.

Cider, served from the big Barrett Tarvia truck, has been a feature of the Road Shows for the past seven years. There will be a plentiful supply of it again this year.

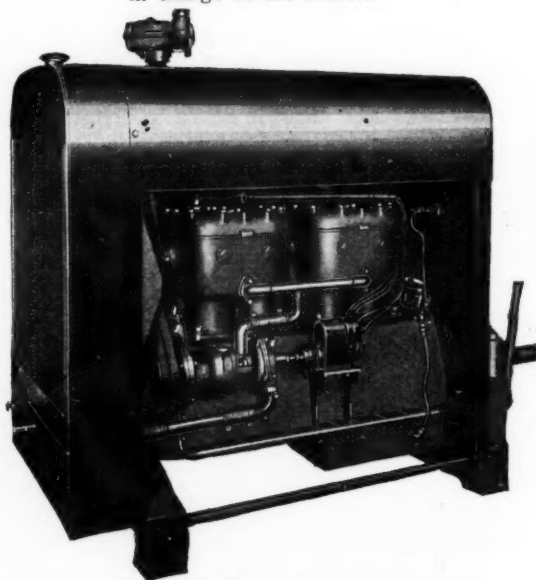
Illustrations and descriptions of the best methods for using Tarvia in road construction have been collected and will be an important part of the exhibit.

Barrett representatives and engineers from all parts of the country covered by Barrett will be in attendance at the Road Show. Men who are experienced in all highway operations and familiar with all local road conditions will be available at the Barrett Booth during the entire period of the Road Show. All questions relative to the use of Barrett products will be answered by the men best qualified to give the information.

Chain Belt Exhibit

The Chain Belt Company will display their line of Rex concrete mixers, Rex pavers, Rex pumps, Rex saw rigs, Rex Plaster and mortar mixers, and Rex contractors elevators and construction equipment at the Cleveland Road Show in space number WW 62.

B. F. Devine, Sales Manager, will be in charge of the exhibit.



CONTINENTAL MOTOR

ANOTHER JOB THAT CAREY DOES...

Wrinkle-proofing roadways

...that you may drive in peace!



"NOW I can let her roll!" you exclaim as you come to a long, level stretch of concrete highway, for you know from experience that, with concrete under the tires, the car will glide along as smoothly as a canoe on a placid stream.

Give her a little more gas . . . there'll be no bumps, no thank-you-marms, no jiggety-joggety . . . for, winter or summer, wet or dry, it's always smooth sailing on concrete!

You've noticed those narrow, black ribbons that run across the road every thirty feet or so? Of course. Well, those are Expansion Joints, and, if they weren't there to allow for cold-weather shrinkage and hot-weather expansion, your beautiful concrete road would be full of detours in a season or two.

One of Carey's many jobs is to make these tough, ever-wearing, self-adjusting cushions that keep concrete from gaping and buckling and breaking under cold and heat—that keep the wrinkles out of roads.

A simple thing, you say, this Expansion Joint idea! And so it is, but in developing and introducing it Carey has made good roads better!—and that, you'll agree, is a very Big Thing indeed!

And into those insignificant-looking, black strips went 54 years of experience and research and work—and those, too, are Big Things when you stop to think of it.

Concrete roads, as you know, are really just beginning to be used—but already Carey Elastite Expansion Joint cushions upwards of 50,000 miles of them . . . *enough clean, smooth highway to twice girdle the globe!*

And this business of road-cushioning is just one of many ways in which Carey contributes to your comfort.

Some of them are extraordinary and all of them are interesting. From time to time we will tell you more about them in these pages.

In the meantime, you might give Carey a grateful thought as the little black road-ribbons go whizzing under the flying wheels of your car.

THE PHILIP CAREY COMPANY, Lockland, Cincinnati, Ohio

Philip
Carey
Products

Please mention PUBLIC WORKS when writing to advertisers.

Link Belt Company

At the Road Show, to be held at the Cleveland Auditorium, Cleveland, Ohio, January 14th to 18th, 1929, the Link-Belt space will be W. W. 9. The principal Link-Belt exhibits will be. A Type K-25, $\frac{3}{4}$ -yard Heavy Duty Shovel; A Type K-55 2-yard Heavy Duty Shovel; and a new Link-Belt "Grizzly" Crawler Loader. These will be supplemented by photographs of Link-Belt machines taken "on the job."

New Koehring Paver to Be Shown at Road Show

The new Koehring 27-E Paver will be exhibited for the first time at the Cleveland Public Auditorium, West Wing 28, during the Road Show, January 14th to 18th. Entirely new from charging skip to boom tip this paver will undoubtedly prove of interest to paving contractors.

In addition to the paver, Koehring



NEW KOEHRING PAVER

will show its 501 shovel with a $1\frac{1}{4}$ -yard dipper and 16-foot dipper sticks. It will be equipped with exclusive Koehring features including the Koehring power dipper trip. Heavy duty construction will be found in the cast steel carbody, multiplane girders and side frames, ball bearing-mounted high speed shafts, and roller bearing-mounted vertical traction and swing shafts.

The Koehring 10-S Dandie will complete the exhibit. This two-bag mixer is suited to a wide range of uses. All control levers are centralized on the drum-end of the mixer for one-man operation. It has an unusually short turning radius—it being possible to turn the mixer completely around in any ordinary street. The 10-S Dandie weighs approximately 4850 pounds.

The Philip Carey Company

The exhibit of the Philip Carey Co., Cincinnati, O., at the Road Show will include: Elastite Expansion Joint, which has been used for many years in important work in all parts of the world, and needs no particular introduction to the road building industry.

Elastite Bridge Flooring. This is a hard, dense, tough composition of asphalt, rag fibre and mineral matter, formed under heavy pressure into slabs of convenient thicknesses, widths and lengths.

Elastite Rail Filler. Used in the form of bituminous preformed slabs as a Rail

Filler in Street Railway Track construction. It prevents the penetration of water into the track structure and by its cushioning effect greatly reduces damage to adjacent pavements and at the same time cuts down noise very materially.

Elastite Track Pavement consists of a system of special shapes of Elastite Track Insulation used in combination with special Elastite Flooring slabs to form a smooth riding, water-tight and durable pavement for Railroad Grade crossings.

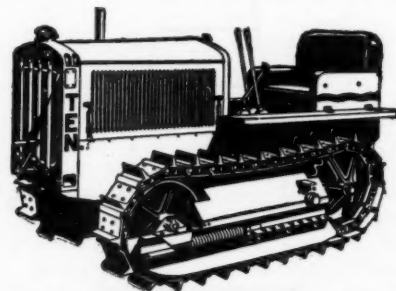
The exhibit will be located in space E. N. 41-42 and will be in charge of C. V. R. Fullenwider and H. C. Jussen.

Barber-Greene Exhibit

The new Barber-Greene Excavator, an entirely new machine, will be the center of attraction at the Barber-Greene booth WW 25 and 35. This Excavator embodies many new features never before seen on a machine of this kind.

Bucket Loader—and Conveyor. All who want to see the latest in material handling equipment should spend some time inspecting these machines.

There will be continuous movies showing the various B-G machines in opera-



THE CATERPILLAR "TEN" TRACTOR WILL BE SHOWN

tion in all parts of the country. One movie of particular interest will be a film—made during the various stages of development on the B-G Excavator—showing the history of the machine.

Galion to Have Elaborate Display at Road Show

Several new Galion developments in road rollers and road graders will be shown at the road show at Cleveland, Ohio, January 14-18 for the first time.

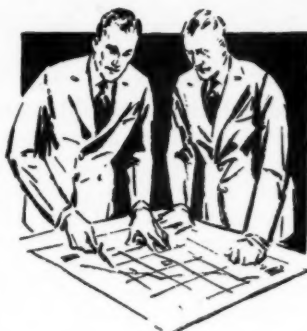
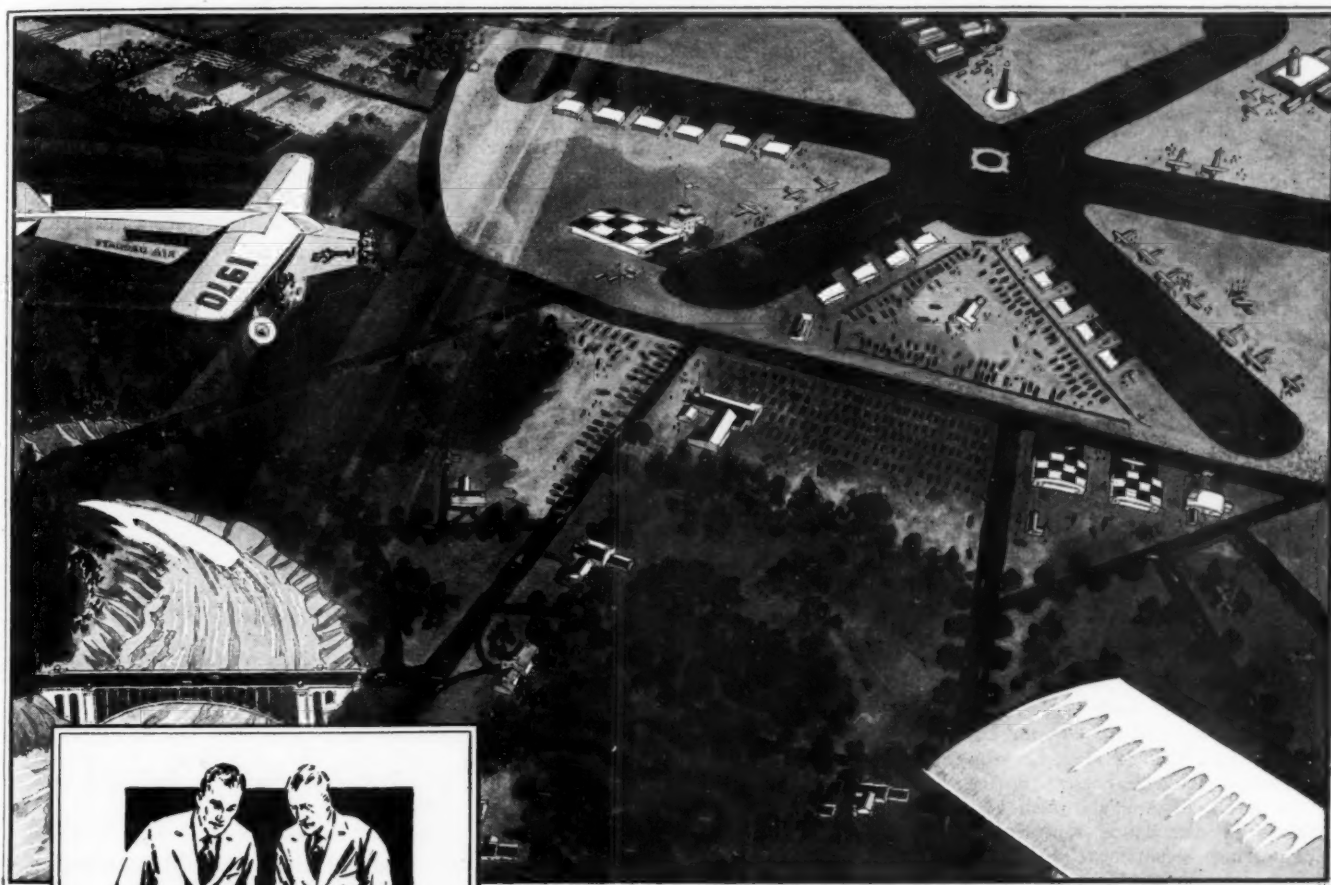
The Galion exhibit at Cleveland will be one of the largest of all the exhibits of road machinery. It will occupy 2580 square feet of space, section W W 5 in the West Wing and Galion has broadcasted an invitation to all road men to make the Galion exhibit their headquarters.

The Galion Iron Works & Mfg. Co. will have a new Roller and Grader catalogue ready for distribution at the road show. This catalogue will give full information about the latest Galion developments in road machinery and will be of interest to anyone planning to purchase a road roller of any kind, a motor grader or a drawn grader of any type. A request addressed to The Galion Iron Works & Mfg. Co., Galion, Ohio, will bring promptly one of the first catalogues off the press.



THE F.W.D. COMMERCIAL UTILITY TRUCK WILL BE EXHIBITED AT THE ROAD SHOW

ROADS *into and out of the sky*



Put it up to the Tarvia Man

Here's 1929 — plans, ways, means, construction and maintenance, purchase and delivery, to be undertaken all over again.

And Barrett is ready. Ask the Tarvia field man to show you what Tarvia can do for you this year. Wire, write or phone—for action.

The *Barrett* Company

New York	Chicago	Philadelphia
St. Louis	Minneapolis	Boston
Detroit	Cleveland	Birmingham
Buffalo	Kansas City	Columbus
Providence	Syracuse	Milwaukee
Baltimore	Toledo	Cincinnati
Lebanon	Youngstown	Rochester
		Bethlehem

In Canada:

THE BARRETT COMPANY, Ltd.
Montreal, Toronto, Winnipeg, Vancouver

TO do what is expected of them, airports must be located near as many good roads as possible. Today, aviation boosters are demanding roads that will make aviation accessible to everyone, *everywhere*.

Tarvia construction will provide these roads at a cost reasonable enough to permit any community to have all the good roads it needs. Tarvia maintenance will keep them top-notch—rutless, stormproof, smooth and skid-safe—indefinitely and economically.

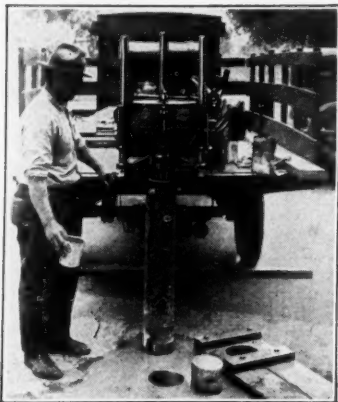
Tarviate your approach roads; Tarviate your airports—and give your fliers and your people a smooth path into the sky.

Tarvia
For Road Construction
Repair and Maintenance

Monarch Tractors Corporation

Monarch Tractors Corporation will exhibit at space WW-50 and will have on display one Model "75" tractor, one Model "50" tractor, one Cutaway Model of "50" tractor in operation, and one new Model "35" tractor, which has just been added to the Monarch line and which was announced a few days ago. In addition to this various parts of these machines will be displayed.

The exhibit will be in charge of W. S. Wonderle, Assistant to the Sales Manager; R. W. Gotshall, President of



SULLIVAN PAVEMENT TESTING CORE DRILL

the Corporation, and H. C. Merritt, General Manager of the Tractor Division of the Allis-Chalmers Mfg. Company, of Milwaukee, will be present during the entire week. There will also be other officials in attendance representing the Engineering Department and Manufacturing Department.

Sullivan Machinery Company

Sullivan Machinery Company products will be shown in an operating exhibit at the American Road Builders Association at Cleveland January 14th, next. Spaces WW-15 and WW-45 at the North end of the West Wing have been assigned for the Sullivan exhibit, giving a space 20x42 feet.

As usual, Sullivan Vibrationless Portable Compressors of several sizes will be on display, although due to the fact that gasoline engines cannot be run in the building, they will be shown idle.

The Sullivan air-operated exhibits will be supplied by a Sullivan WG-6 7x6 compressor, of the single stage, horizontal type, operated by short belt drive from a 15 H. P. electric hoist.

Drill Steel bits and shanks will be forged on a Sullivan portable drill sharpening machine, exemplifying the typical Sullivan Allhammer process. The bits will be heated for forging in a Sullivan portable oil furnace.

Other operating exhibits will include demonstrations of Sullivan "Rotator" hammer drills, concrete breakers, and clay spaders. A Sullivan portable compressed air hoist will be available with air on the machine, to demonstrate its control, and a Sullivan electric driven double drum dragline hoist will be

shown. A Sullivan Pavement testing core drill will be a new feature of the exhibit.

Ralph T. Stone, Cleveland office manager, will be in general charge of the Sullivan exhibit. Assisting him will be Raymond B. Hosken, General Sales Manager, Chicago; Joseph H. Brown, Chicago District Sales Manager; Chicago; W. H. Duffill, Detroit; Oscar R. Cundy, Pittsburgh; Chester G. Cummings, Syracuse; also Clement Reeves, D. B. Martin, and S. M. Pierce, of the Cleveland staff.

Sullivan equipment distributors will be given an opportunity of studying the Sullivan exhibit on Saturday, January 12.

Solvay Sales Corporation

The Solvay Sales Corporation, New York City, will display Solvay Flake Calcium Chloride which is used on gravel roads to lay the dust, for curing concrete roads and for removing ice and snow from pavements during cold weather months.

The following representatives will be present: G. H. Kimber, H. F. Clemmer, L. N. Smith, G. C. Schroeder, H. E. Hattersley, P. M. Goodwin, C. P. Grossman, C. Kleinhaus, V. R. Ewing, G. P. Spencer.

Good Roads Machinery Company

The Good Roads Machinery Company will have an exhibit in the West Wing, located in the second aisle to right after entering from the Esplanade, in Exhibit Space WW-61.

Equipment to be exhibited will be interesting in view of the fact that it will include only the latest types, embodying developments in improved design, effectiveness and simplicity of operation.

Among the machinery on exhibit will be the new Good Roads Champion Distributor for the application of asphalt and tar products. This distributor will be fully mounted on truck chassis.

Attached to the White Model 55 Truck, on which the Champion Distributor will be mounted, will be a Model 10-C Champion Snow Plow

equipped with the new Good Roads-Westingshouse Pneumatic Lifting Device,—the only pneumatic lifting device yet developed. This will be connected and in operation, so that anyone may at will demonstrate the advantages of this improvement for controlling the raising and lowering of a snow plow.

One of the pieces of equipment shown will be the new type Y-75 Good Roads Motor Grader. This machine also embodies many novel features and, although not a heavy machine, it combines simplicity in construction and operation, fine adjustment, and great strength.

A very complete working model—one-quarter actual size—of The Champion No. 1030 Roller Bearing Reduction Crusher, electrically driven, will be shown. A complete photographic display of all products manufactured and sold by the Company will be exhibited.

This company will also have an exhibit at the convention of the National Sand and Gravel Association, in Booth 48, and also one in Booth 14 at the convention of the National Crushed Stone Association. Both of these conventions convene at the Hollenden Hotel.

The executives of the company who will be in attendance during the Road Show are Earle S. Philips, Vice President and Gen. Mgr.; R. S. Tucker, Ass't to Vice President; C. G. A. Schmidt, Jr., Chief Engineer; and several others.

Heltzel Bins and Measuring Devices

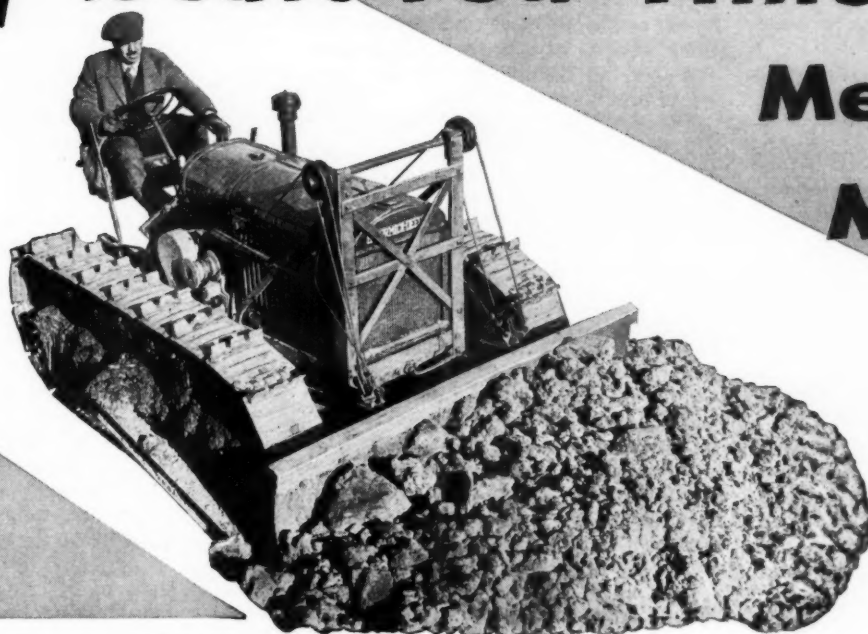
The Heltzel Steel Form & Iron Company of Warren, Ohio, have made improvements in their steel bins, and weighing and volume grabbers during the past year. On all-steel bins of 35 and 55-ton capacity, the reinforcing members have been improved to add still further rigidity. The slope of the hopper plates has been increased to 50 degrees, which insures ready flow of materials. The 55-ton bin is flanged on four sides.



GOOD ROADS DISTRIBUTOR

HARNESS TRACKSON POWER to Save YOU Time -

Men -
Money!



TRACKSON TRACTOR EQUIPMENT

THIS Master Equipment for the McCormick-Deering Tractor is designed and built with one thought in mind—to help YOU do a real job under any conditions—with the least man power, in the shortest time!

All we ask is that you sit behind the Trackson Full-Crawler—Feel its dominating brute force under you—Ride with it through and over the most stubborn obstacles. Its mighty grip and sure-footed power will astound you! Its simplicity of construction also permits quick, easy change of equipment. Off with one piece—on with the other. No complicated hook-ups or long delays. Eager, versatile power—when and where you want it!

Whatever the job—excavating, earth-moving, snow removal, hauling, plowing, stump-pulling, back-filling, scarifying, grading, leveling and crowning, sub-grading, resurfacing—Trackson equipment is ready to save you time, men, money.

Let us tell you about the Trackson Full-Crawler, Shovel, Crane, Bulldozer and Loader—the equipment with hundreds of uses! Let Trackson Power serve and save for you. Write for full details . . . NOW!

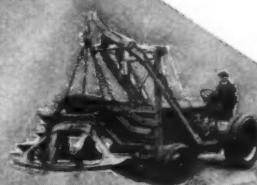
Trackson Company

FULL-CRAWLERS & TRACTOR EQUIPMENT

503 CLINTON ST.

MILWAUKEE, WIS.

Visit the Trackson Tractor-Equipment Exhibit at the Cleveland Road Show—Space WW44



Trackson Crane



Trackson Shovel



Trackson Crane with Full-Crawler



Model DH Full-Crawler

The Heltzel volume agrabatchers have been improved as regard minor changes. The top gates are so constructed to prevent materials getting into wearing parts and jamming; the operating gears and ratchets increased in size to permit easier operation, and the design of toggles changed to permit greater track clearance.

A choice as to method of operating is also given. 1st—By means of a lever, permitting operation from ground; 2d—By means of chain and wheel, permit-



NEW HELTZEL BIN

ting operation from ground or platform; 3d—Hand Wheel, permitting operation from platform. In addition, a geared adjusting device for quick changing of capacity on volume agrabatchers may be had at a slightly higher cost.

The Heltzel Steel Form & Iron Company has developed what is known as the "Heltzel Duplex Weighing Agrabatcher."

This agrabatcher is rectangular in form, with hopper bottom in two compartments, and amply large to hold the quantities of material necessary for the ordinary batch used in road and other types of construction work. The capacity of the stone compartment is 3,000 pounds, or approximately 31 cu. ft., and the sand compartment has a capacity of 2,000 pounds, or approximately 20 cu. ft.

The Heltzel Duplex Agrabatcher is equipped with an American Kron Automatic Springless Dial Scale, having a 36-inch dial graduated to 5,000 pounds by 5-pound graduations. This dial is mounted on a special structural steel support, which is carried to the outside members of the bin, and is equipped with pointers which can be set to any desired position on the rim.

The weights of the materials are predetermined, and the pointers then set at the weights of the sand and stone, and a third pointer set at the weight of the combined batch of sand and stone. The operator may then either weigh sand or stone separately—weighing one batch and then the other; or he may weigh the

batch of sand and stone together, first weighing either sand or stone by bringing the hand opposite the pointer as set for the material which he happens to weigh first, and then weigh the amount of the other aggregate by bringing the hand to the pointer as set for the combined weight of sand and stone. This gives almost any desired combination, and does not require the operator holding to any fixed set of rules.

The dial being 3 feet in diameter enables the inspectors on the job to see at a glance exactly what the weight of any batch may be. The hand on the dial automatically returns to zero, and the operator or inspector is able to check the scales for every batch in an instant.

The Heltzel Steel Form & Iron Company also manufacture a similar weighing agrabatcher for weighing quantities of one material only, either sand to 2,000 pounds, or stone to 3,000 pounds. They also manufacture a weigh larry, utilizing the same principles as in the Duplex Agrabatcher. With this equipment one has the advantage of weighing a number of grades of material from a battery of bins or silos.

Rome "High-Lift" Graders

The Rome Mfg. Company, Rome, N. Y., will have a large exhibit of their "High Lift" Graders, both drawn type and motor driven, at the Good Roads exhibit will be located in the Central Armory, Space A-Y-41.

This company has added several new models to their line during the past year, and these machines will be on exhibit at the Show.

The Rome Mfg. Company has made great strides in the grader industry dur-

ing the past few years, and their products are meeting with the approval of users throughout this country and foreign countries. This company is keeping in mind at all times, their slogan, "The Best Bargain is Quality."

The exhibit will be in charge of E. C. Gledhill, the inventor of Rome "High Lift" Graders.

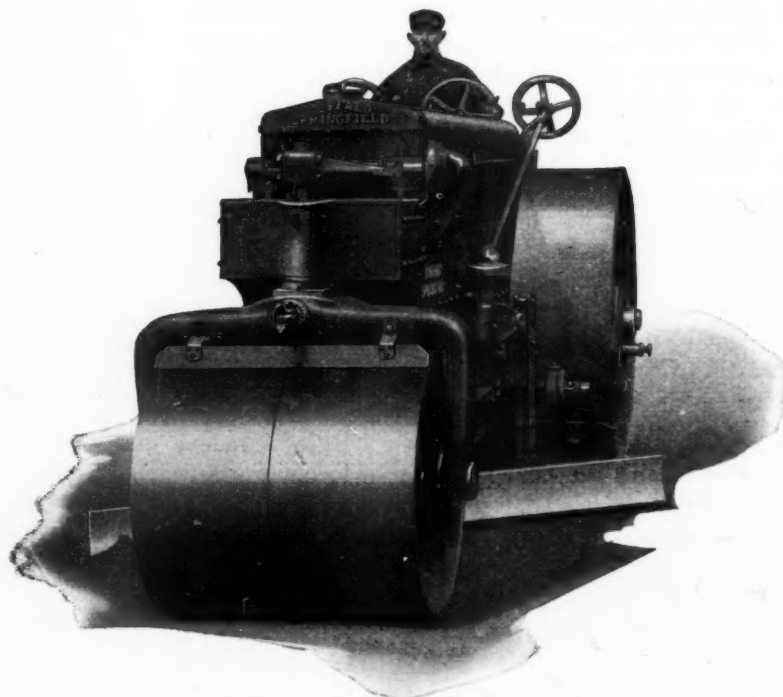
The Buffalo-Springfield Roller Company

The manufacturers of the Buffalo-Springfield rollers will occupy space in the northeast corner of the West Wing. But, as they build road and paving rollers exclusively and produce variations of over twenty different models, the space available is inadequate to show more than an outline of the complete line. This will be accomplished by showing their smallest gasoline motor-driven tandem, weighing about two tons, their 10-ton Heavy Duty motor-driven tandem, their large three-wheel motor-driven roller for heavier scarifying and in contrast a smaller size, weighing only five tons, equipped with grading blade and scarifier.

Photographs of other models of both steam and gasoline motor-driven rollers in sizes between those shown will be on exhibition. Descriptive circulars, bulletins, and booklets will be distributed to those who may be interested.

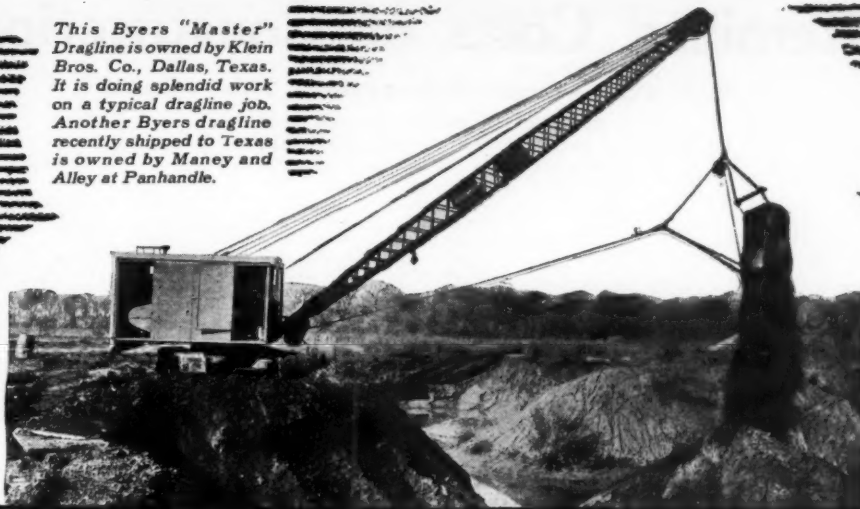
It has been their experience that all Buffalo-Springfield rollers exhibited at the Annual Road Show have been sold before the closing day and the machines are shipped direct to the purchasers instead of being returned to the factory.

The Buffalo-Springfield exhibit will be in charge of W. J. Hazeltine and W. H. McClenen, who will be registered at the Hollenden Hotel.



BUFFALO-SPRINGFIELD 3-WHEEL ROLLER WITH GRADING BLADE

This Byers "Master" Dragline is owned by Klein Bros. Co., Dallas, Texas. It is doing splendid work on a typical dragline job. Another Byers dragline recently shipped to Texas is owned by Maney and Alley at Panhandle.



the 2,671 st

NEW BYERS

GOES to TEXAS

TWO thousand six hundred seventy-one!

Consider the experience that this figure represents—the experience in designing and building good excavating and handling equipment.

All over Texas, all over the United States and Canada, Byers Shovels, Cranes and Draglines are proving their worth. Always good value, they are better now than ever, because we know how to build them better as a result of this vast fund of experience.

Owners of Byers rigs of years past are now buying the new models, because they are satisfied that these are the finest and most up-to-date equipment to be had, and they know that Byers stands back of every machine one hundred per cent.

See this 1929 Byers line— $\frac{1}{2}$ to $1\frac{1}{4}$ cu. yd.—at the Road Show, or send for the new Catalogs.

THE BYERS MACHINE CO., Ravenna, Ohio
Sales and Service Throughout the Country

BYERS

Shovels & Cranes

Please mention PUBLIC WORKS when writing to advertisers.

BYERS
RAVENNA-OHIO

Itemized Costs of Construction

Wolf Point—Circle Highway—5.97 Miles—Gravel

Roosevelt and McCone Counties, Montana

Bids received Oct. 23, 1928, by Montana State Highway Commission
(Contract awarded to Lalonde Construction Co.)

No.	Item	Quantity	Unit	Highway Commission's Estimated Cost	Thomas Staunton, Great Falls, Montana	J. E. Hilton, Miles City, Montana	Stevens Bros., St. Paul, Minn.	Lalonde Const. Co., Bainville, Montana	Stanley Bros., St. Cloud, Minnesota
1	Unclassified excavation	101,323	cu. yd.	.25	.26	.24	.0278	.0245	.26
2	Overhaul	253,080	sta. yd.	.02	.04	.02	.015	.03	.03
3	Crushed gravel surf. in top course	4,619	cu. yd.	1.80	2.20	2.40	1.61	1.55	1.55
4	Crushed gravel surf. in base course	4,593	cu. yd.	1.65	2.00	2.40	1.41	1.55	1.55
5	18" corr. metal pipe culvert	564	lin. ft.	1.75	1.42	1.55	1.50	1.25	1.45
6	24" corr. metal pipe culvert	274	lin. ft.	2.25	2.10	2.25	2.00	2.00	2.10
7	30" corr. metal pipe culvert	56	lin. ft.	3.00	2.50	2.70	2.75	3.00	2.60
8	36" corr. metal pipe culvert	164	lin. ft.	4.50	3.80	6.00	4.00	4.00	4.20
9	Class "B" concrete in headwalls	20.42	cu. yd.	28.50	30.00	30.00	28.00	25.00	35.00
10	Class "A" concrete in box culv.	135	cu. yd.	29.50	30.00	30.00	28.00	30.00	25.00
11	Reinforcing steel	13,025	lb.	.08	.08	.08	.07	.08	.065
12	Clearing	3.5	acre	100.00	80.00	100.00	50.00	5.00	75.00
13	Wire cable guard rail	3,980	lin. ft.	.60	.60	.65	.55	.50	.45
14	Binder for gravel surface	1,500	cu. yd.	.40	1.50	1.00	1.00	.25	.30
15	Overhaul on binder	500	cu. yd. mi.	.25	.25	.30	.30	.25	.25
16	Stock piled gravel	600	cu. yd.	1.65	1.90	2.00	1.51	1.55	1.50
Total.....				\$58,853.97	\$69,842.06	\$65,605.42	\$58,264.22	\$57,812.13	\$58,907.40

Washington State Highway No. 22—5.40 Miles

Stevens County, Washington.

Bids received Oct. 9, 1928, by State Highway Engineer.
(Contract awarded to Triangle Construction Co.)

Item	Quantity	Unit	Triangle Construction Co., Spokane, Wash.	James Tobin & Son, Metaline Falls, Wash.	Peck & Einerson, Hoquiam, Wash.	B. J. Deretick, Ellensburg, Wash.	Clifton, Applegate & Toole, Spokane, Wash.	M. E. Nelson Const. Co., Inc., Tonasket, Wash.
Clearing	34.00	acres	\$65.00	\$45.00	\$100.00	\$200.00	\$75.00	\$70.00
Grubbing	15.80	acres	65.00	45.00	100.00	50.00	75.00	90.00
Class "A" excavation, incl. haul of 400 ft.	178,480	cu. yds.	.28	.30	.30	.29	.32	.34
Solid rock excavation, incl. haul of 400 ft.	9,069	cu. yds.	1.10	1.00	1.00	1.00	1.20	1.20
Structure excavation, incl. haul of 400 ft.	450	cu. yds.	.70	1.00	.75	.80	1.00	1.00
Overhaul on above material per each 100 ft.	146,260	cu. yds.	.02	.03	.02	.02	.025	.025
Common backfill in place	780	cu. yds.	.50	.50	.50	.60	1.00	.50
Plain conc. or V. C. pipe 18" diam. in place	1,134	lin. ft.	2.50	2.50	2.25	2.50	2.50	2.50
Reinf. conc. pipe, R.R. type 18" diam. in pl.	472	lin. ft.	4.00	4.00	3.75	3.00	4.25	4.50
Totals.....			\$71,530.60	\$74,795.80	\$75,558.20	\$76,413.40	\$81,448.10	\$84,812.70

State Road No. 4—Lewis County—5.19 Miles

(Contract awarded to Halleran Bros.)

Item	Quantity	Unit	Halleran Bros., Seattle, Wash.	von der Hellen & Pierson, Medford, Ore.	G. H. Gallows Co., South Tacoma, Wash.	Hammer, Keto, James & Brown, Rochester, Wash.	John Slotte & Co., Inc., Astoria, Ore.
Clearing	4,930	acres	\$400.00	\$500.00	\$475.00	\$600.00	\$700.00
Grubbing	2,650	acres	450.00	600.00	600.00	600.00	1,000.00
Class "A" excavation, incl. haul of 400 ft.	86,050	cu. yds.	.49	.45	.52	.50	.40
Solid rock excavation, incl. haul of 400 ft.	6,500	cu. yds.	1.00	.70	1.20	1.15	1.00
Structure excavation, incl. haul of 400 ft.	750	cu. yds.	1.00	2.00	1.10	1.00	2.00
Class "D" excavation, incl. haul of 400 ft.	1,970	cu. yds.	1.00	.70	1.50	1.50	1.50
Overhaul on above materials, per each 100 ft.	141,460	cu. yds.	.02	.02	.025	.03	.03
Gravel backfill in place	60.00	cu. yds.	3.00	1.00	4.00	5.00	2.00
Concrete, Class "B" in place	86.82	cu. yds.	25.00	34.00	30.00	40.00	45.00
Concrete, Class "C" in place	3.58	cu. yds.	40.00	34.00	30.00	40.00	35.00
Steel reinforcing bars, in place	8,120	lbs.	.10	.07	.08	.10	.08
Timber and plank in place	36.00	M.B.M.	50.00	65.00	63.00	75.00	70.00
Furnishing cedar piling at site	1,100	lin. ft.	.40	.50	.20	.50	.50
Driving piles	52	only	10.00	12.00	10.00	15.00	10.00
Totals.....			\$94,415.20	\$99,365.50	\$109,098.10	\$116,954.80	\$123,141.60



EISEMANN

The Foremost Magneto

~ for Construction Equipment

The overwhelming choice of the builders of high quality equipment. Favored by contractors everywhere.

EISEMANN MAGNETO CORPORATION
165 Broadway - New York

Please mention PUBLIC WORKS when writing to advertisers

Missouri River Bridge—Length, 1,073 Feet

Wolf Point—Circle Highway, Roosevelt and McCone Counties, Montana
Bids received Oct. 23, 1928 by Montana State Highway Commission
(All bids rejected)

No.	Item	Quantity	Unit	Highway Commission's Estimated Cost Unit price	McGuire & Blakeslee Great Falls, Mont. Unit price	W. P. Roscoe, Billings, Montana Unit price	Minneapolis Bridge Co., Minneapolis, Minn. Unit price	Missouri Valley Bridge & Iron Co., Leavenworth, Kansas Unit price
1	Structural steel	1,334,000 lb.		.08	08.1	07.5	.10	08.6
2	Steel castings	20,350 lb.		.12	.16	.14	.10	.15
3	Reinforcing steel	227,000 lb.		.04	.065	06.5	.07	.06
4	Old railroad rails	55,000 lb.		.06	.04	.05	.05	02.5
5	Bronze expansion plates	620 lb.		.54	.75	.70	.25	.43
6	Class "D" concrete	810 cu. yd.		25.00	29.00	26.00	25.00	35.00
7	Class "A" concrete	2,140 cu. yd.		23.00	29.00	24.00	30.00	40.00
8	Class "B" concrete	4,365 cu. yd.		18.25	29.00	21.00	40.00	32.00
9	Unclassified structure excavation	2,160 cu. yd.		6.00	6.00	5.00	8.00	6.00
10	Caisson excavation	7,600 cu. yd.		14.50	15.80	24.20	8.00	8.50
11	Concrete rail and curb	410 lin. ft.		5.00	7.00	6.00	10.00	4.00
12	Cast iron floor drains	110 each		4.00	7.00	6.00	7.00	6.50
13	Foundation piling	12,150 lin. ft.		1.25	.90	1.25	1.00	1.60
14	Hand placed rip rap	100 cu. yd.		4.50	12.00	6.00	8.00	10.00
Total				\$415,735.55	\$489,680.00	\$498,550.50	\$509,180.00	\$487,023.10

Paradise Bridge—Length, 971 Feet

Knowles-Weeksville Highway, Sanders County, Montana
Bids received Oct. 23, 1928, by Montana Highway Commission
(Contract awarded to R. E. Mieth)

No.	Item	Quantity	Unit	Highway Commission's Estimated Cost Unit price	R. E. Mieth, Portland, Ore. Unit price	Illinois Steel Bridge Co., Spokane, Wash. Unit price	McGuire & Blakeslee Great Falls, Mont. Unit price	W. P. Roscoe, Billings, Mont. Unit price	Sam Boudrye, Thompson Falls, Mont. Unit price
1	Structural steel	1,140,000 lb.		.07 1/2	.069	.07	0.0675	.0698	.07
2	Steel castings	13,500 lb.		.12	0.20	.20	.16	.16	.20
3	Reinforcing steel	169,000 lb.		.06	0.06	.05	.052	.052	.06
4	Old railroad rails	12,000 lb.		.04	0.06	.05	.035	.04	.06
5	Bronze expansion plates	870 lb.		.55	0.70	.60	.60	.60	.60
6	Class "A" concrete	3,300 cu. yd.		21.00	15.00	20.00	20.46	18.00	22.50
7	Class "D" concrete	900 cu. yd.		25.00	15.00	24.00	20.46	24.00	22.50
8	Concrete curb and rail	430 lin. ft.		3.00	2.00	4.00	4.00	3.00	3.00
9	Foundation excavation	2,700 cu. yd.		7.50	5.00	8.00	9.40	10.00	10.00
10	Foundation piling	10,500 lin. ft.		.90	.020	.55	.69	1.10	.90
Total				\$221,008.50	\$196,229.00	\$208,767.00	\$209,117.00	\$212,362.00	\$226,122.00

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